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GOVERNMENT OF INDIA

MINISTRY OF AGRICULTURE & IRRIGATION

(DEPARTMENT OF AGRICULTURE)

U. P.

(BHAGIRATHI, BHILLANGANA AND YAMUNA CATCHMENTS)

VOLUME-I

INVENTORY RESULTS

PRE-INVESTMENT SURVEY OF FOREST RESOURCES

DEHRA DUN.

1976

Contents

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VOLUME- I.

REPORT ON FOREST RESOURCES

PREINVESTMENT SURVEY OF FOREST RESOURCES

DEHRA DUN

(All volume figures are in Cubic metres WRE)

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P R E F A C E

U.P. Forest Department wanted the Bhagirathi, Bhilangana and Yamuna catchments to be surveyed by the Preinvestment Survey of Forest Resources organisation. The main objectives were to prepare the inventory resources of the area; to indicate accessibility and cost study and to carry out market and demand studies.

2. This work was taken up in 1971 and most of the field work was completed during the financial year 1971-72. Later on, however, in a meeting held at Lucknow in the office of the Chief Conservator of Forests, the U.P. Forest Department desired the preparation of volume tables, the quantum of work obviously increased and the field work, therefore, continued till June, 1973. The report writing has been delayed, some what, because of the transfer of all the officers of this organisation who actually worked in the field.

3. The survey has, by and large, revealed that the area is rich in forest resource and the wood raw material which is available for industrial purpose is as under according to the 2 alternative models of working:-

Industrial Wood	Volume in '000' M^3	
	MODEL-I	MODEL-II
1. Coniferous.	55.00	124.00
2. Oaks	171.00	189.05
	226.00	313.05

On the basis of this information it can be recommended that the industrial production of the following capacities may be taken up:-

Sl.No.	Kind of Wood	Kind of Pulp	Yield	Capacity in day	
				Model-I	Model-II
1.	Coniferous	Ground Wood	90%	111	249
		Semi Chemical	70%	86	194
		Chemical	50%	62	138
2.	Oak.	Ground Wood.	90%	342	378

From the above it should not be presumed that area will continue to be a rich forest resource for all times to come. The population is growing and the demands are increasing. A very interesting study on the demand and supply has also been conducted. It has, therefore, been recommended that artificial means of regeneration have to be resorted to in order to supplement natural regeneration so that needs of the future developments can also be catered to. The information provided in the report will broadly be very useful to the U.P. Forest Department because on the basis of this they can now go ahead with the preparation of intensive management plans bearing in mind the projections

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of supply and demand of the next 30-40 years which can be easily marked on the basis of model (technique) used in the report.

5. In the preparation of this report, besides other members of the staff of this organisation special credit goes to Shri A.P. Dwivedi, Dy. Conservator of Forests, Northern Zone, Preinvestment Survey ofForest Resources who has worked hard in finalising it particularly in view of the fact that he did not have the field experience in the area because he joined the project after the field work was over.

6. The work done by the Data Processing Officer, Shri G.S. Negi and his assistants is also acknowledged.

DATE: 16.5.1976

DEHRA DUN

ROMESH CHANDRA
Chief Coordinator
National Forest Resources Survey

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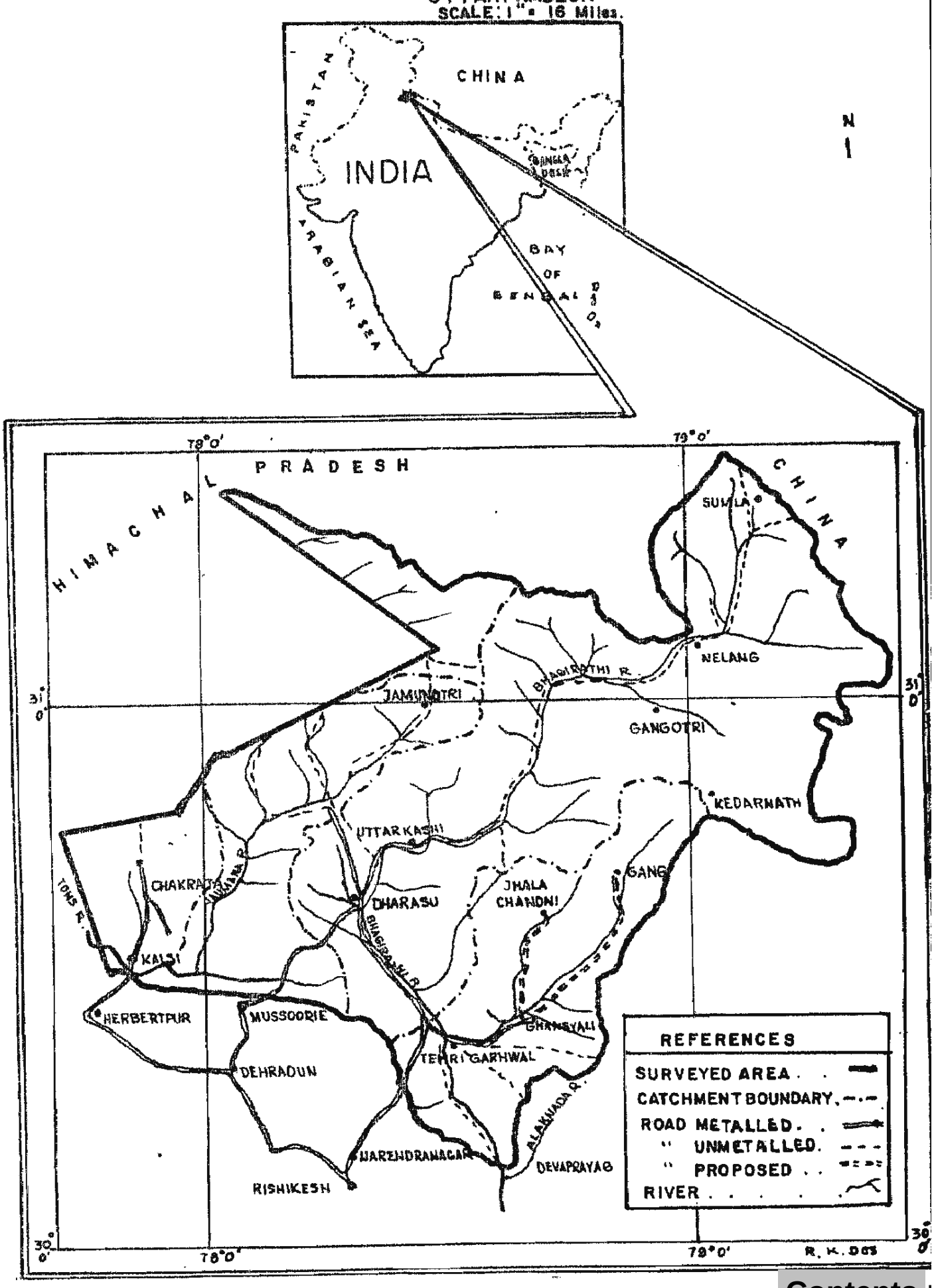
NATIONAL FOREST RESOURCES SURVEY.

BHAGIRATHI, BHILLANGANA & YAMUNA CATCHMENTS.

UTTAR PRADESH

SCALE: 1" = 16 Miles.



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SUMMARY

CHAPTER - 1.

THE SURVEY AREA

1. The total geographical area covered by Preinvestment Survey in the catchments of Yamuna, Bhagirathi & Bhilangana of Uttar - Pradesh is 10336.02 Sq. Km.

2. The area lies between the latitudes 30° 0' N and 31° 30' N and longitude 77° 45' E' and 79° 30' E approximately.

3. The entire area is hilly and the elevation varies from 600 metres to 5000 metres from M.S.L.

4. Variety of geological formations occur in the area. Soil varies from sandy to clayey in nature. Annual rainfall is about 1500 mm.

5. Infra-structure is poor in the area. There is no railway. Coniferous timber is normally transported through streams & rivers. Broad leaved species are transported through roads.

6. Total population according to 1971 census is 6,44,707. 93.5% population is rural, mostly engaged in agricultural pursuits.

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SUMMARY

CHAPTER - II.

INVESTIGATION AND METHODOLOGY.

OBJECTIVES

1. To prepare the inventory of forest resources of the area.

2. To undertake accessibility and Cost Studies.

3. To carry out Market & Demand Studies.

PRECISION

4. To estimate the total growing stock within 5% standard error.

METHODOLOGY

5. Systematic cluster sampling has been used for forest inventory.

6. Area estimates under different land use were obtained on the basis of number of sample points falling in a particular land use by giving the area weightage to each sample point.

7. Methodology has been discussed in detail under relevant chapters for inventory, Cost and Accessibility Study, Volume and Cull Factor Study in volume II of the report.

8. Data was mainly processed using the IBM/1620 Model II Electronic Data Processing System.

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SUMMARY

CHAPTER - III.

LAND USE PATTERN AND FOREST TYPES

1. On the basis of distribution of sample points the area under different land use pattern has been found as under.

AREA UNDER LAND USE CLASS

Sl. No.	Land use class	No. of sample points.	Area (Sq.Km.)	Percentage
1.	Forest Land			
	(a) Tree forest	972	3873.02	37.5
	(b) Scrub forest	64	255.01	2.5
	Total	1036	4128.03	40.0
2.	Agricultural Crop Land	297	1183.42	11.4
3.	Non-forestry plantation	6	23.91	0.2
4.	Pasture Land	85	338.69	3.3
5.	Barren Land	1151	4586.26	44.4
6.	Other Land	19	75.71	0.7
	Total	2594	10336.02	100%

2. For the purpose of tabulation the following forest types were identified

FOREST TYPES	SPECIES
i) Chir	Chir
ii) Blue pine & Deodar	Kail and Deodar
iii) Fir/Spruce	Fir and Spruce
iv) Oaks	Ban, Mohru and Kharsu oak
v) Lowland hard wood	low land hard woods
vi) Upland hard wood & mixed forests	Upland hard wood and mixed coniferous.

3. The area under different forest types as calculated by giving the area weightage to each sample point works out as under.

AREA UNDER DIFFERENT FOREST TYPE

Forest type	No. of sample points	Area in hectares	S.E. %
Chir	288	122172	5.5
Blue pine & Deodar	50	21210	14.28
Fir and Spruce	51	21635	15.86
Oaks	399	169259	4.60
Low Land hard woods	23	9757	20.76
Upland hard woods	102	43269	9.70
Total	913	387302	2.54

SUMMARY

CHAPTER - IV

VOLUME TABLES AND GROWING STOCK

1. 210 trees of different species were felled for preparation of Volume Tables. Multiple regression equations were tried between Volume, Diameter and height in respect of general volume equations and between volume and diameter in case of local Volume equations. Local volume tables have been prepared for Chir, Kail, Deodar, Fir/Spruce, Ban oak, Mohru Oak and for rest of Broad Leaved species.

2. Area and growing stock figures of different forest types are as under :

Forest Type	Area in hectares	Volume per hectare	S.E. %	Total vol. in 000 cu. m.
Chir	122172	130.33	4.07	15922.7
Bluepine & Deodar	21210	275.09	9.74	5834.7
Fir & Spruce	21635	280.76	8.34	6074.2
Oak	169259	203.11	4.07	34378.2
Low Land hard woods	9757	48.83	19.35	476.4
Upland hard wood	43269	193.97	7.25	8392.8
Total -	387302	183.52	2.76	71079.0

3. Data in respect of cull Study were insufficient and therefore, it was considered unsafe to use these figures. From the experience of survey in similar areas of Himachal Pradesh and Jammu & Kashmir, the cull has been assumed in Kail, Fir/Spruce and Oaks as 5%, 20% and 25% respectively.

4. Net growing stock after deducting the cull volume works out as under.

NET GROWING STOCK

Species	Volume in 000 cubic metres	
	Gross	Net (After deduction of cull)
Chir	15658.4	15658.4
Kail	1443.4	1371.2
Deodar	4338.4	4338.4
Fir & Spruce	7074.9	5659.9
Oaks	28421.1	22065.8
Others	13142.8	13142.8
Total	71079.0	62236.5

SUMMARY

CHAPTER - V.

RATE OF GROWTH

1. Mean annual increment for Chir, Kail, Deodar, Fir and Oaks in Chir, Blue pine, Deodar, Fir/Spruce and Oak forest types respectively has been worked out in relation to mean age of these species, and is given below :

MEAN ANNUAL INCREMENT AND MEAN AGE

Species	Mean Age	M. A. I. in cubic metres/hectare
Chir	46	2.65
Kail	40	1.20
Deodar	60	3.07
Fir	93	2.18
Oak	42	3.54

2. Periodical increment for the last 10 years and for previous 10 years, in basal area for different coniferous species has been worked out on the basis of data on increment rings of sample trees. Mean Annual Increment in Cubic metres per hectare has been calculated taking into consideration this growth and the number of stems per hectare. These M.A.I. figures for different species are given below :

CHAP.V

SUMMARY

Species	Forest types	MA.I. per hectare for the last 20 years worked out on the basis of tree increment.
Chir	Chir	2.75
Kail	Bluepine -Deodar	1.08
Deodar	-do-	3.49
Fir	Fir/Spruce	2.33

3. Since the figures of M.A.I. for different species calculated on the basis of number of stems per hectare and mean age are slightly on lowerside, it was considered safe to adopt these figures for further calculation.

SUMMARY

CHAPTER - VI

PRESENT MANAGEMENT PRACTICES AND FUTURE PROPOSALS

1. The objectives of present management are generally to prevent soil erosion, help soil and moisture conservation by way of providing protecting cover, to improve the quality of the forest, to meet the local demand and harvesting the safe maximum annual yield.

2. The forest under the control of forest department are covered by regular working plans and are being managed scientifically. The forests are being managed mainly with a view to producing large size timbers for railway sleepers and other constructional materials. Broad leaved species are generally managed for fuel. Present management is not industrial oriented.

3. Future proposals for management have been made with a view to meeting the demand of local population and to provide raw materials for proposed wood based industries.

4. Two cutting models have been suggested. The objectives of these models are :

MODEL-I

Production of large sized trees so as to meet the requirement of railway sleepers and other constructional timbers, as is the practice at present.

MODEL-II

Production of raw materials for pulp and paper mill and for wooden packing cases. Trees of 40 cm. diameter at B.H. are considered suitable for meeting these requirements.

The exploitable diameter and the rotation under the two different cutting models are as under :

Contents

CHAP-VI SUMMARY

Species	MODEL-I		MODEL-II	
	Exploitable diameter (cm)	Rotation (Years)	Exploitable diameter (cm)	Rotation (Years)
Chir	60	120	40	65
Kail	60	150	40	80
Deodar	60	150	40	80
Fir	60	150	40	100
Oaks	35	120	30	100

6. The Annual cut for different species under the two cutting models is worked out and is given as under

Species	Annual cut in Cubic metres	
	MODEL I	MODEL II
Chir	2,92,000	4,03,000
Bluepine	22,000	30,000
Deodar	61,000	87,000
Fir/Spruce	61,000	80,000
Oak	4,83,000	5,20,000

SUMMARY

CHAPTER - VII

MARKET AND DEMAND STUDIES

1. Market and Demand Studies were under-taken in order to work out the present level of production and consumption in the area and also to forecast the level of wood consumption for the years 1981 and 1991.

2. The total recorded production of wood in the area is 3,34,064.19 cubic metres. Out of which the production of timber and fuel wood is 3,18,712.86 and 15351,33 m^3. respectively. Species-wise and area-wise figures are given below :

Total Average Annual Production from the Zone

Unit-Cubic metres

Source	Chir	Kail	Deodar	Fir/Spruce	Others	Total	Fuel Wood Coniferous	Fuel Wood B.L.	Total
A. GOVT. FORESTS									
(i) Through Lessee	193198.11	8578.41	9306.78	67130.47	2978.33	281192.10	1041.97	8739.72	9781.69
(ii) Through Deptt. Agency.	4598.65	219.57	198.20	94.21	337.25	5441.88	-	0.20	0.20
(iii) Right Holders Concessionist.	17955.69	1064.42	1297.67	2026.83	1573.76	23918.37	-	5465.28	5465.28
TOTAL (A)	215752.45	9862.40	10796.65	69251.51	4889.34	310552.35	1041.97	14205.20	15247.17
B. REVENUE FOREST	2223.72	1.96	34.88	-	-	2260.56	-	-	-
C. PRIVATE LANDS	4723.37	732.22	410.37	31.59	2.40	5899.95	-	104.16	104.16
TOTAL (B+C)	6947.09	734.18	445.25	31.59	2.40	8160.51	--	104.16	104.16
GRAND TOTAL (TOTAL A+B+C)	222699.54	10596.58	11241.90	69283.10	4891.74	318712.86	1041.97	14309.36	15351.33

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SUMMARY

3. The requirement of wood for the purpose of house construction and repairs is estimated at 34557.80 cubic meters annually.

4. Consumption of wood for agricultural implements has also been worked out. This comes to 17099.95 cubic metres annually.

5. The total requirement of wood for the purpose of fuel has been worked out. The actual recorded production of fuel wood which is 15351.33 cubic metres has only been considered for working out the wood balances.

6. There are 21 units of furniture making and few units for making packing cases.

7. The present consumption of wood by different category of wood users have been assessed and is given below :

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SUMMARY WOOD CONSUMPTION IN THE AREA

IN THE YEAR 1972 - 73

S. No.	Item	SPECIES Chir	Kail	Deodar	Fir/ Spruce	B.L.	Total
1.	House Construction & repairs.	17278.90	2764.62	10367.34	-	4146.94	34557.80
2.	Agricultural implements.	2565.00	-	855.00	-	13679.95	17099.95
3.	Fuel (Recorded)	625.18	78.15	78.15	260.49	14309.36	15351.33
4.	Other domestic uses.	3223.50	-	-	-	3223.50	6447.00
5.	Industries :						
	(a) Furniture Industry	70.00	70.00	325.00	-	118.00	583.00
	(b) Packing case.	26520.00	-	-	6630.00	-	33150.00
	(c) Hydel Projects	-	-	8908.00	-	7809.00	16717.00
	(d) Other Department	520.21	2.32	15.05	-	23.26	560.84
Total internal consumption		50802.79	2915.09	20548.54	6890.49	43310.01	124466.92
	(i) Railways	22706.53	42.36	765.72	3282.34	-	26796.95
	(ii) D.G.S. & D.	2445.76	57.51	1048.27	6524.80	-	10076.34
Total of committed export.		25152.29	99.87	1813.99	9807.14	-	36873.29
GRAND TOTAL		75955.08	3014.96	22362.53	16697.63	43310.01	161840.21
or say		75955	3015	22363	16698	43310	161341

Contents

8. Most of the wood produced in the area is exported outside in the timber markets of Yamuna Nagar, Dehradun, Raiwala etc.

9. The demand for the years 1981 and 1991 has been projected and is given in the following table,

TOTAL SPECIES WISE CONSUMPTION OF WOOD FOR THE YEAR 1972, 1981 AND 1991.

Species	1972	1981	1991
Chir	75955	123833	218067
Kail	3015	5688	11013
Deodar	22363	32591	54433
Fir/Spruce	16698	23108	35753
Broad leaved	43310	75988	141062
TOTAL	161341	261118	460328

SUMMARY

CHAPTER - VIII.

WOOD BALANCES

1. The wood balances for the years 1972, 1981 and 1991 has been calculated for two different cutting models and is given below :

WOOD BALANCE (in 000 m^3)

	YEARS					
	1972		1981		1991	
	MODEL		MODEL		MODEL	
	I	II	I	II	I	II
Chir	216	327	168	279	74	185
Kail	19	27	16	24	11	19
Deodar	39	65	28	54	7	33
Fir/Spruce	44	65	38	57	25	44
Oaks	440	477	407	444	342	379
Total	758	959	657	858	459	660

2. It is assumed that Deodar will be felled only to the extent for meeting the requirements of local population and surplus if any will be exported outside the area for uses other than paper and pulp. The volume available for industrial purposes from Chir, Kail, Fir/Spruce and Oaks would be as follows :-

CHAP. -VIII SUMMARY

WOOD AVAILABLE FOR INDUSTRIAL PURPOSES

in '000 cubic metres

Species	YEARS 1972		1981		1991	
	Model I	Model II	Model I	Model II	Model I	Model II
Coniferous wood (Chir, Kail, Fir and Spruce)	279	417	222	360	110	248
Oaks	440	477	407	444	342	379
Total	719	894	629	804	452	627

3. It may take few years to establish a pulp and paper mill. It is therefore proposed that the wood balances available for this purpose in the year 1991 should only be considered for industrial purposes.

4. Entire quantity of wood balances may not be available for utilization on account of silvicultural requirements, inaccessible and difficult terrain and ~~several~~ other factors. Therefore it is assumed that only50% of these wood balances will be available for industrial purposes. The quantities available under the two cutting models would be as under :

Model	Industrial Wood	Volume (in 000 m^3)
I	Coniferous	55.0
	Oaks	171.0
	Total	226.0
II	Coniferous	124.0
	Oaks	189.5
	Total	313.5

Contents

SUMMARY

C H A P T E R - IX

ACCESSIBILITY AND COST STUDIES

1. The main objectives of these studies were to find out the economic availability of wood raw material for establishment of wood b industries at two proposed sites e.g. Rishikesh and Dak Pathar.

2. Conventional tools are mostly used for logging purposes. Coniferous species are generally removed in form of sleepers and broad leaved species are removed in form of logs.

3. The area was divided into catchments on the drainage pattern. The catchments are Bhilangana, Bhagirathi, Yamuna and Tons. Catchments are further divided into cost units. The costs have been calculated for brining the wood to Rishikdesh from the catchments of Bhilangana and Bhagirathi and to Dak-Pathar from Yamuna and Tons.

4. Costs of different logging operations were collected from case studies covering the entire range of variations such as topography and working conditions. Forest Lessees and subcontractors were interviewed with the help of carefully designed proformas.

5. The summary of costs of var[illegible] operations of logging is given as under.

SUMMARY OF COST PER CUBIC METRE FOR VARIOUS OPERATIONS

ITEM		Average cost/m^3 in Rs.	
1.	Marking		0.030
2.	Felling including roping & loping	(a) Coniferous (b) Broad leaved	4.75 6.25
3.	Cross-cutting		4.46
4.	Sleeper making	(a) Manual Sawing (b) Machine Sawing	34.45 23.05
5.	Engraving property mark.	(a) Sleepers (b) Logs	0.30 0.12
6.	MINOR TRANSPORT		
	i) Rolling	9.35/km	
	ii) Manual carriage	12.23/km	
	iii) Carriage on mule back	5.15/Km.	
	iv) Dry slide	5.23/Km.	
	v) Wet slide	2.87/km.	
	vi) Telescopic floating	0.36/km	
	vii) Gravity ropeways	3.60/km	
7.	MAJOR TRANSPORTATION		
	i) Road transport including (loading & unloading)		
	(a) Hill Kachha	0.90/km.	
	(b) Hill Pucca	0.63/km	
	ii) (a) Floating (Bhagirathi & Bhilangana)	0.15/km	
	(b) " (Yamuna)	0.21/km	
8.	Amenities to labour	10% on all items from serial No. 2 to 6	
9.	Over head charges	Rs. 10=00 per cubic metre.	

Contents

CHAP-IX SUMMARY

6. The distribution of volume (Growing stock) and its percentage by different cost classes for delivery at Rishikesh and Dakpathar is given below :-

Cost class in Rs. (per cubic metre)	Volume in '000' cubic metres	% age of total volume
Less than 100	3880	5.5
100-160	42720	60.1
Rs. 160 and above	21890	30.8
Uneconomical	2589	3.6
	71079	100

7. Two new roads have been proposed to be constructed. These are :-

S. No.	Name of the Road	Approximate distance in km.
I	Ghansali to Gangi Ghansali to Jhala-Chandani	60 Km. 40 Km.
		100.00

CHAPTER - X

SUMMARY

INDUSTRIAL POSSIBILITIES

1. The survey has revealed that the area is rich in forest resources. The wood raw material which is available for industrial purposes is as under :-

Industrial Wood	Volume in ' 000 M^3	
	MODEL I	MODEL II
1. Coniferous	55.00	124.00
2. Oaks	171.00	189.05
	226.00	315.05

2. Considering that 1.5 cubic metres of wood is equal to one tonne in weight, the available wood in tonnes per annum for industrial purposes would be :-

Industrial Wood	Weight in Tonnes	
	MODEL-I	MODEL-II
1. Coniferous	37000	83000
2. Oaks	114000	126000
	151000	209000

3. Assuming 300 working days in a year. The capacity of industries that may be set up for different kinds of pulp is given below :-

S.No.	Kind of Wood	Kind of Pulp	Yield	Capacity in/day MODEL I	MODEL II
1	Coniferous	Ground Wood	90%	111	249
		Semi chemical	70%	86	194
		Chemical	50%	62	138
2	Oak	Ground Wood	90%	342	378

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4. If smaller unit of pulp mill is planned the area can also feed a medium size plywood mill.

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SUMMARY

RECOMMENDATIONS

1. Sufficient raw material is available for establishing pulp and paper mills of the capacities as indicated in table No. X-1. Other aspects for installation of pulp and paper has of course to be got investigated separately.

2. Dead, dying, diseased and over mature trees should be removed on priority basis.

3. There should be balanced blending of mechanised means and conventional method of logging in order to extract the material at the cheapest cost. Portable saw mills may be used for conversion in the forest. Existing roads may be improved and new roads may be taken up for construction as early as possible.

4. Artificial means of reganeration have to be adopted to supplement natural regeneration of different species.

5. Deodar may continue to be managed with the objective to produce large size timber. Other species such as Chir, Kail, Fir and Spruce may be required to be worked under shorter rotation if the pulp and paper mill is set up.

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(CHAPTER - I)

THE SURVEY AREA

General information

1. NAME

The survey area i.e. the catchments of rivers Yamuna, Bhagirathi & Bhilangana and part of Tons covering Uttarkashi, Tehri and part of Dehradun Districts, will be referred, hereafter, as the 'area' in this report.

2. LOCATION

The area lies between latitudes 30° 0' N and 31°30' N and longitude 77°45' E and 79°30' E approximately.

3. AREA

The total geographical area of the survey is 10336.02 sqs kms.

4. SITUATION

In the North it is bounded by the high ridge separating Uttar Pradesh from Himachal Pradesh and China, The Southern boundary is formed by the ridge separating the Bhagirathi and Ganga Catchments starting from Devparyag to Mussoorie and Kalsi. The ridge separating Bhilangana and Alakhanda Catchments forms the Eastern boundary and the inter-state boundary between Himachal and Uttar Pradesh forms the Western boundary.

The area includes the following Forest Divisions :-

(i) Complete area of Uttarkashi and Yamuna Forest Divisions.

(ii) Bhilangana, Tehri and part of Maniknath Range of Tehri Forest Division.

(iii) Molta, Rikhinan, River and part of Kansar Range of Chakrata Forest Division.

(iv) Parts of Supin, Rupin and Singtur Ranges of Tons Forest Divisions.

(v) Small portion of Dehradun Forest Division.

5. TOPOGRAPHY

The entire area is hilly and undulating. The elevation varies from 466 metres near Haripur to 5381 metres near Thagala. The threemajor catchments i.e. Yamuna, Bhagirathi and Bhilangana, separated by high ridges. Most of the area has elevation between 2000 to 3000'm. Slppes vary from steep to precipitous in all the catchments. Slopes in Yamuna catchment are comparatively easier.

6. GEOLOGY

A variety of geological formations belonging to different age groups are found in the area. Most of the formations belong to the Carboniferous, Permian, Archean, Tertiery & Crustaceous age. The major formations are Chail, Simla slates, Garhwal series, Deoban Lime stone, Jaunsar, Krol, Chandpur, Nagnath, Granite and other crystalline formations. The important rock types in these formations, are sand stone, quartzite, orthoquartizite, grit, conglomerate, limestone, shales, slates, phyllite, gneiss, schist, granitic and other crystalline rocks.

7. SOIL

Physical and chemical properties of rocks and the processes of weathering affect the properties of Soil. Mechanical weathering of sand-stone and quartzite gives rise to sandy soils while soil formed from Shales, slates etc. are clayey in nature. The important soil types found in the area are Red Loam, Brown forest. Podzols and Meadow soils. The led loams are generally found along the slopes of hills and along the ridges. The brown forest soils occur in greater part of the area. The organic matter content is quite high. The soils are granular, clayey or clayey micaceous, or some times loamy in nature. Podsol development is met with on the mild slopes in the pockets of hills in shady places. These are clayey to loamy in texture and generally dark brown to black in colours. Meadow soils are characterised by high ground water level with thick matting of grasses during the entire season. These are dark granular, sandy loam or sandy in texture.

8. CLIMATE

The climate of the area is temperate with very severe winter. The summer is mild. Annual rainfall varies from 800 mm. to 2500 mm. The configuration of the ground exercises a great influence on the distribution of monsoon. The heaviest rainfall occurs along the outer hills. The first ridge forms the barrier and considerably checks the force of monsoon. The moisture bearing winds coming from plains loose much of their water as they ascend the first abrupts slopes of the mountains, passing northwards successively. The higher ranges take their toll till the last ascent of snowy peaks drain the current of their moisture. Summer rains are very scanty in the north of snowy peaks.

Snow-falls: In higher areas 50% of the annual precipitation is in the form of snow. The areas with altitude of 3000 meters or more remain snowbound for most of the year.

9. INFRASTRUCTURE

Railways: There are no railways in the area. The nearest rail-heads are Rishikesh and Dehradun, which are 45 Km. and 80 Km. respectively from the nearest boundary of the survey area.

Roads: The road density in the area is 125km/59km. Total length of all types of roads being 1206 Kms. A few new roads are being constructed. The names with type of roads have been given in the appendix I. Most of the broad leaved species are being extracted through roads.

10. STREAMS & RIVERS

Streams and rivers are the cheapest means of timber transport system in the area. Most of the coniferous species are transported by rivers. The important rivers with floatable distance (free floating) are given below :-

(i) Bhilangana - 170 Km.

(ii) Bhagirathi - 250 Km.

(iii) Yamuna - 120 Km.

11. NATURAL RESOURCES

The area is rich in natural resources which have not been utilised mainly due to poor means of road communication. Besides, vast wealth flora and fauna, there are rich deposits of Gypsum and other minerals. The net work of rivers forms the source of major irrigation and Power Projects.

The important forest types as per Champian and Seth's classification

(i) Northern tropical dry mixed deciduous forests (5 B/C 2)

(ii) Himalayan sub tropical pine forest - (9/C 1)

(iii) Lower Western Himalayan temperate forest (12 C/1)

(iv) Upper Western Himalayan temperate forest (12 C/2)

(v) Montane Himalayan moist temperate forest (12 DS/1)

....4/-

12. EXISTING INDUSTRIES AND MARKETS:

In the area, there is no major wood based industry. Most of the timber produced is supplied to the timber markets at Dehradun, Yamuna Nagar and Riawala (all situated outside the survey area)

13. THE PEOPLE

The total population of the area, according to 1971 census, is 6,44,707 out of which 93.5% is rural mostly engaged in agricultural and pastoral pursuits. The main crops are maize, rice, wheat, barley, Kodo etc. Fruit cultivation has also gained popularity in recent years.

Sheep rearing is also common mostly in higher ranges. The villagers make woollen clothes and blankets known. The literacy in the area is 18.5% compared to 21.6% for whole of the U.P. With the creation of Garwhal University at Srinagar literacy % age is going to jump considerably.

The people are generally poor. The per capita income for the year 1971, according to 1971 census is Rs. 275/- at 1960-61 price-level. People are simple in nature. Landless rural population generally work as agricultural labourers. Some are also engaged in other operations such as forest working, road construction etc.

.....5/-

CHAPTER- II

INVESTIGATION AND METHODOLOGY

On the recommendation of working Group of Planning Commission on Forest Development and Utilisation (U.P. Hill Districts), Preinvestment Survey of Forest Resources, in the catchments of Yamuna, Bhagirathi & Bhilangna rivers lying in the Districts of Uttarkashi, Tehri & Dehradun was taken up. The following investigations were carried out.

(i) Inventory of forest resources of the area.

(ii) Accessibility & Cost Studies.

(iii) Market & Demand Studies.

1. INVENTORY OF THE FOREST RESOURCES:

The main objectives for the inventory studies were :

a) to estimate the total area under different land uses :

b) to estimate area under different forest types.

c) to estimate the total growing stock within 5% of standard error and its distribution under different forest types.

d) to prepare local volume tables of important species.

e) to estimate the growth rate of important species.

f) to calculate annual cut for alternative management practices.

g) to prepare resource map with the help of photointerpretation.

2. MARKET & DEMAND STUDIES:

The main objectives of these studies were :

a) to find out the present level of wood production in the area.

b) to estimate the present level (1972-73) of wood consumption in the area.

c) to survey the present status of Timber Markets of the area.

d) to foreseast the level of wood consumption for the years 1981 & 1991.

.....6/-

CHAPTER II

3. COST & ACCESSIBILITY STUDIES :

The objective of these studies was :-

to estimate the cost at which the raw-materials may be made available on the proposed industrial sites. (Two tentative sites were fixed namely Rishikesh & Dakpathar).

4. METHODOLOGY:

a) Forest Inventory :- Please refer to Volume II of this Report.

b) Photointerpretation : Aerial photographs on the scale of 1:60,000 taken during 1961, were available for whole of the area. These were however, received very late and were not of a good quality.

Efforts were made to use the existing aerial photographs :-

i) to estimate the area under different land use.

ii) to estimate the area under different forest types.

iii) to prepare a Forest Resources Map for management.

Due to small scale of photography, it was not possible to achieve the above objectives.

c) Market & Demand Study : The present production figures were collect from the Reports of Forest Divisions. Sample surveys were conducted to estimate the wood requirement for construction and repair of houses agricultural implements and for fuel. Available data from different sources were also collected and have been quoted at relevent places. Please refer to Chapter VII of this Report.

d) Accessibility & Cost Studies : Please refer to Chapter IX of Volume I & Part II of Volume II of the Report.

CHAPTER- III

LAND USE PATTERN AND FOREST TYPES

1. LAND USE PATTERN

On the basis of distribution of sample points the area under the present land use pattern has been worked out as under :-

Table No. III - 1

AREA UNDER LAND USE CLASS

Sl.No.	Land use class	No. of sample point.	Area (Sq.Km.)	Percentage
1.	Forest Land			
	(a) Tree forest	972	3873.02	37.5
	(b) scrub forest	64	255.01	2.5
	Total	1036	4128.03	40.0
2.	Agricultural Crop Land	297	1183.42	11.4
3.	Non-forestry plantation	6	23.91	0.2
4.	Pasture land	85	338.69	3.3
5.	Barren land	1151	4586.26	44.4
6.	Other Land	19	75.71	0.7
	Total	2594	10336.02	100%

These area figures could not be checked with the photo-interpretation as the available aerial photographs were old of poor quality and on a small scale. As pointed out in Chapter II these were also received very late.

2. FOREST TYPES:

For the purpose of tabulation the following forest types are indentified :-

FOREST TYPES

i) Chir

ii) Blue pine & Deodar

iii) Fir including spruce

iv) Oaks

v) Low land hard woods

vi) Upland hard woods and mixed conifers

(For definition of forest types please refer to Vol. II of this report).

3. BREAK-UP TOTAL FOREST AREA INTO DIFFERENT FOREST TYPES:

Each sample plot has been given equal weightage for calculation of area. This weightage comes to 424.21. For calculation of area under each forest type, the number of plots in the forest type works out as under :-

Table No. III - 2

AREA UNDER DIFFERENT FOREST TYPE

Forest type	No. of sample points.	Area in heacares	S.E. %
Chir	288	122172	5.5
Blue pine & Deodar	50	21210	14.28
Fir and spruce	51	21635	13.86
Oaks	399	169259	4.60
Low Land hard woods	23	9757	20.76
Upland hard woods	102	43269	9.70
Total	913	387302	

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CHAPTER-III

4. AREA BY FOREST DIVISIONS AND FOREST TYPE:

The distrubution of area by forest types in the six forest divisions of the catchment is worked out and given in the table No. III - 3

Table No. III-3

FOREST AREA BY FOREST TYPES AND DIVISION:

Forest Division	FOREST TYPES: Fir including Spruce	Blue pine & Deodar	Chir	Upland hard woods & mixed conifers.	Oaks	Low land hard woods	Total
						AREA-Sq-Km.	
1	2	3	4	5	6	7	8
Chakrata	25.45 (6)	55.15 (13)	33.93 (8)	25.45 (6)	114.54 (27)	38.18 (9)	292.7 (69)
Tons	-	-	8.49 (2)	4.24 (1)	-	-	12.73 (3)
Yamuna	25.45 (6)	55.15 (13)	292.70 (69)	123.02 (29)	559.95 (132)	16.97 (4)	1073.24 (253)
Uttar Kashi	148.48 (35)	84.84 (20)	526.02 (124)	165.44 (39)	538.75 (127)	-	1463.52 (345)
Tehri	16.97 (4)	16.97 (4)	360.53 (85)	114.54 (27)	479.85 (113)	25.45 (6)	1015.86 (239)
Dehradun	-	-	-	-	-	16.97 (4)	16.97 (4)
Total	216.35 (51)	212.10 (50)	1221.72 (288)	432.69 (102)	1692.59 (399)	97.57 (23)	3873.02 (913)

NOTE :- Figures within the brackets indicate the number of smple points.

CHAPTER - IV

VOLUME TABLES AND GROWING STOCK

1. PREPARATION OF VOLUME TABLES :

The following trees were felled for preparation of volume tables :-

Table No. IV. IV - I

NO. OF TREES FELLED

Species	Dia - Class										Total
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	
Shir	4	8	11	7	1	-	-	-	-	-	31
Kail	3	10	11	9	2	-	-	-	-	-	35
Deodar	2	6	6	5	6	5	1	2	-	-	33
Fir & Spruce	4	10	13	7	1	2	-	-	-	3	40
Ban Oak	5	8	4	-	-	-	1	-	1	-	19
Moru Oak	2	3	3	3	4	4	3	-	-	-	22
Others	7	6	9	4	2	-	2	-	-	-	30

2. Multiple regression equations for measured volume of the trees to their diameters (over bark at breast height) and total height were fitted. The general volume equations and the local volume equations fitted are given in the Technical Report on data processing in volume II of this report.

3. Local volume tables for different species are reproduced below :-

Table No. IV - 2

LOCAL VOLUME TABLES
(Volume in Cu.m.)

UTTARKASHI INVENTORY RESULTS

Diameter (Cm)	Chir	Kail	Deodar	Spruce *	Fir	Ban Oak	Mohru Oak	Rest of Spc
20	.159	.229	.327	.043	.310	.155	.194	.133
25	.285	.380	.511	.184	.419	.266	.345	.207
30	.473	.590	.737	.405	.583	.415	.547	.337
35	.723	.859	1.004	.709	.800	.602	.800	.521
40	1.035	1.188	1.312	1.094	1.072	.828	1.103	.760
45	1.409	1.576	1.661	1.561	1.399	1.092	1.457	1.054
50	1.845	2.024	2.051	2.109	1.780	1.395	1.862	1.404
55	2.343	2.532	2.482	2.739	2.216	1.737	2.318	1.808
60	2.903	3.099	2.954	3.451	2.706	2.117	2.825	2.266
65	3.525	3.725	3.467	4.244	3.251	2.535	3.382	2.780
70	4.210	4.412	4.021	5.119	3.850	2.992	3.990	3.349
75	4.956	5.157	4.616	6.075	4.503	3.488	4.650	3.973
80	5.764	5.963	5.253	7.114	5.211	4.022	5.359	4.652
85	6.635	6.827	5.930	8.233	5.974	4.595	6.120	5.386
90	7.567	7.752	6.648	9.435	6.791	5.206	6.932	6.174
100	9.618	9.779	8.208	12.082	8.588	6.544	8.707	7.916
105	10.737	10.882	9.050	13.529	9.568	7.270	9.671	8.870
110	11.917	12.044	9.932	15.057	10.603	8.035	10.686	9.878
115			10.856	16.666	11.692	8.839	11.752	10.941
120			11.820	18.357	12.836	9.681	12.868	12.060
125			12.826	20.130	14.034	10.562	14.035	13.233
130			13.873	21.984	15.286	11.481	15.253	14.461
135			14.961	23.920	16.594	12.439	16.522	15.744
140			16.089	25.939	17.955	13.435	17.842	17.082
145			17.259	28.037	19.371		19.213	18.475
150			18.470	30.218	20.842		20.634	

Contents

Data on only 18 felled trees and 51 sample trees were available. Therefore, the equation may not be considered dependable. This, however, does not materially affect the total growing stock figures because fir and spruce grow together and number of spruce trees in this mixture is rather meagre.

GROWING STOCK:

Using these volume tables on plot enumeration data plot volumes were calculated. These plot volumes were grouped together in each forest type and figures for volume/hectare in each forest type were computed. The results are given below in Table No. IV-3

Total Surveyed area	1033602 hectares
Total Forest area	412803 hectares
Total number of sample points in the area	2594
Total No. of points in tree forest	972
Total No. of points visited.	913

Table No. IV-3

Forest type	Area in hectares	Volume per hectare @ 20 cm.	S.E. %	Total vol. in 000 cu. m.
Chir	122172	130.33	4.07	15922.7
Bluepine & Deodar	21210	275.09	9.74	5834.7
Fir & spruce	21635	280.76	8.34	6074.2
Oak	169259	203.11	4.67	34378.2
Low Land hard woods	9757	48.83	19.35	476.4
Upland hard wood	43269	193.97	7.25	8392.8
Total	387302	183.52	2.76	71079.0

5. DISTRIBUTION OF GROWING STOCK/HECTARE

The distribution of volume per hectare by different forest types and by species is given in Table No. IV-4

Table No. IV-4

DISTRIBUTION OF VOLUME/HECTARE IN m^3

SPECIES

Forest Type	Chir	Kail	Deodar	Fir/ spruce	Oak	Others	Total
Chir	121.82	-	0.43	-	5.64	2.44	130.33
Kail	2.06	47.98	184.37	3.72	23.89	13.07	275.09
Deodar							
Fir/ Spruce	-	4.42	5.74	202.60	44.49	23.51	280.76
Oak	1.68	1.03	0.99	9.59	148.62	41.19	203.11
Upland hard wood	10.30	3.60	1.93	22.87	48.71	106.56	193.97
Lowland hard wood	-	-	-	-	-	48.83	48.83

The distribution of total growing stock by different forest types and species is worked out and given in Table No. IV-5

Table No. IV.-5

DISTRIBUTION OF VOLUME BY SPECIES IN 000 m^3

Forest type	SPECIES						
	Chir	Kail	Deodar	Fir/ spruce	Oak	Others	Total
Chir	14883.0	-	52.6	-	689.0	[illegible]	15922.7
Kail	45.7	1017.7	3910.8	78.9	506.7	275.2	5334.7
Deodar							
Fir/ Spruce	-	95.6	124.2	4383.3	962.7	[illegible]	[illegible]
Oak	286.0	174.3	167.6	1623.2	25155.3	697.[illegible]	[illegible]
Upland hard wood	445.7	155.8	83.5	989.5	2107.6	4610.7	8392.[illegible]
Lowland hard woods	-	-	-	-	-	476.4	476.4
Total	15658.4	1443.4	4338.4	7074.9	29421.1	13142.8	71079.0

7. CULL

Cull means natural defects in wood which make it unsuitable for any purpose except as fuel. The loss of volume in wood due to defects like rot, hollowness, knots, etc. is called cull volume and it is excluded to arrive at the net volume. The data for cull was collected from the felled trees and analysed. The number of observations were small and therefore it was considered unsafe to use these figures. However, from the experience of surveys in similar areas such as Himachal Pradesh and Jammu and Kashmir the following cull volume for each species is assumed :-

1.	Chir	...	Nil
2.	Deodar	...	Nil
3.	Kail	...	5%
4.	Fir & spruce	...	20%
5.	Oaks	...	25%

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8. NET GROWING STOCK

After giving allowance for the cull the net growing stock of different species from all the forest types is calculated and given in table No. IV - 6.

Table No. IV-6

NET GROWING STOCK

Species	Volume in 000 cubic metres	
	Gross	Net (After deduction of cull)
Chir	15658.4	15658.4
Kail	1443.4	1371.2
Deodar	4338.4	4338.4
Fir & Spruce	7074.9	5689.9
Oaks	29421.1	22095.8
Others	13142.8	13142.8
Total	71079.0	62236.5

...

...

CHAPTER - V

RATE OF GROWTH

1. DIAMETER - AGE - HEIGHT RELATIONSHIP

From felled tree data diameter classes were plotted against mean age of the trees in the diameter class. A smooth curve was drawn age/diameter for chir, Kail, deodar, fir and spruce. Corrections were applied for age upto the breast height. As the felled tree data in respect of Fir and Spruce were inadequate, recourse has been taken to the existing yield tables of U.P. The diameter-age curves for different species have been given in figaures to 5 at the end of this report. Similarly graphical relations were developed for age and height relationship for different coniferous species. The results are tabulated in table No. V-1.

Table No. V-1

Estimated age & height against the mid point of the diaclass:

Dia. (Cm)	Age (Year)				Height (Meter)				
	Chir	Kail	Dáodar	Fir/ Spruce	Chir	Kail	Deodar	Fir	Spruce
15	26	25	30	59	9.8	12.5	13.6	11.0	7.0
20	34	32	39	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	42	40	48	80	16.4	17.8	20.4	18.2	13.5
35	60	63	69	100	21.3	21.8	24.5	23.3	19.9
40	70	77	81	111					
45	84	95	94	122	24.9	24.0	27.1	27.0	25.3
55	128	-	132	143	27.6	26.5	28.7	29.7	29.8
60	-	-	158	154					
65	-	-	199	166	29.7	27.3	30.0	31.8	33.5
75				190	31.3	28.5	30.8	33.4	35.5
85				218	32.5	29.5	31.4	34.7	38.8
95				250	33.6	(30.3)	31.9	35.7	41.0
110						(31.3)	32.5	37.0	43.3

Contents

2. DISTRIBUTION OF STEMS PER HECTARE

The distribution of number of stems per hectare in each forest type by important species in 10 cm. diameter classes is given in the appendix II of this report. This abstract is given in table No. V-2

Table No. V-2

DISTRIBUTION OF NUMBER OF STEMS PER HECTARE

Forest type	Species						
	Chir	Kail	Deodar	Fir/ spruce	Oak	Others	Total
Chir	295.87	-	0.61	-	18.24	24.04	338.76
Bluepine/ Deodar	3.91	106.59	215.86	7.76	66.61	54.69	455.42
Fir/ Spruce	-	8.68	2.04	205.78	78.66	70.97	366.13
Oak;							
Upland hardwoods	17.10	3.84	2.44	24.85	65.24	605.05	718.52
Lowland hardwoods	4.40	3.02	1.30	14.86	445.80	307.42	776.80

From the study of the tables of distribution of stems per hectare it is inferred that :-

i) The distribution of stems per hectare is satisfactory in respect of Chir, Deodar and Oaks in Chir, Bluepine and Deodar and Oak forest types respectively.

ii) In Blue pine - Deodar forest type, the distribution of Kail shows a marked fall from dia class 60-70 on wards.

iii) In fir and spruce forest type, the trees of fir & spruce below 10 cm. diameter are completely absent. The distribution from diameter 10 cm onwards is satisfactory.

(iv) The other broad leaved species have more number of stems per hectare in upland hardwood forest type compared to the number of stems/hectare in lowland hardwood forest type.

3. DISTRIBUTION OF VOLUME HECTARE

The distribution of volume per heactare of the species in 10 cm. diameter classes is given in Appendix No. III of this report. From the study of these tables it is evident that :-

i) The volume/hectare of fir and spruce in fir & spruce forest type, increases up to the diameter class 40-50 cm and thereafter gradully decreases. The volume per hectare is maximum in 40-50 cm diameter class.

ii) In case of Kail in Blue pine - Deodar forest type the volume per hectare is maximum in diameter class 30-40 cm. and then there is steep fall in vol/hectare. Volume/hectare in diameter class 90-100 cm and above is nil.

iii) Deodar, in Blue pine - Deodar forest type, has the maximum volume per hectare in diameter class 30-40 cm and there after there is a steady decrease in upper diameter classes.

iv) Volume per hectare of Chir in Chir forest type is maximum in the diameter class 30-40 cm and there is a steep fall of volume per hectare from diameter class 70-80 cm and onwards.

v) The distribution of volume per hectare, in different dia-classes is stisfactory. Maximum volume/hectare occurs in 50-60 cm. diameter class.

4. DISTRIBUTION OF NUMBER OF STEMS PER HECTARE BY DIFFERENT DIAMETER CLASSES AND THEIR CORRESPONDING MEAN AGE

The distribution of number of stems per hectare by different diameter classes and the age corresponding to the mid point of each diameter class for Chir, Kail, Deodar, Fir/spruce and oaks has been worked out from age/diameter curve and is given in table No. V-3

Table No. V-3

NUMBER OF STEMS AND THEIR MEAN AGE

Dia Class	Chir in chir type		Kail in Deodar Bluepine.		Deodar in Bluepine-deodar type		Fir/Spruce in fir spruce type		Oaks in oak forest type	
	No of Stems/ ha.	Age	No. of stems/ ha.	Age	No. of stems/ Ha.	Age	No. of stems/ Ha.	Age	No. of stems/ Ha.	Age
10	42.98	-	6.28	-	6.29	-	-	-	97.22	-
10-20	99.55	26	54.63	25	66.11	30	64.37	59	196.48	27
20-30	73.71	42	18.54	40	66.50	48	51.46	80	76.31	54
30-40	45.13	60	16.11	63	43.93	69	37.83	100	33.04	99
40-50	21.08	84	7.54	95	21.39	94	23.70	122	18.52	-
50-60	9.89	128	2.45	-	11.50	132	12.93	142	11.20	-
60-70	2.62	-	.50	-	5.96	199	7.54	163	5.96	-
70-80	.66	-	.28	-	2 .45	-	3.01	190	3.75	-
80-90	.17	-	.21	-	.67	-	2.65	218	1.64	-
90-100	.05	-	-	-	.58	-	1.28	250	0.94	-
100-110	.04	-	-	-	0.24	-	0.72	-	0.48	
110 +	-	-	-	-	0.24	-	0.29	-	0.26	

The age diameter relationship for oaks is obtained from the "volume tables for the forests of Uttar Pradesh by Shri S. K. Seth 1957 " and also from the " Provisional yield tables by Shri H.G. Champion and Shri I.D. Bhindura 1934 "

5. DISTRIBUTION OF VOLUME PER HECTARE BY DIFFERENT DIA-CLASSES AND THEIR CORRESPONDING MEAN AGE

The distribution of volume per hectare by different diaclasses and their corresponding age (read from the graph against mid point of. each diameter class) of Chir, Kail, Deodar, Fir/ Spruce and Oaks in Chir, Bluepine-Deodar, Fir-Spruce and Oak forest type respectively has been worked out and is tabulated in table No. V-4.

Table No. V-4

DISTRIBUTION OF VOLUME PER HECTARE BY DIFFERENT DIAMETER CLASSES AND THEIR CORRESPONDING MEAN AGE

Dia Class	Chir in Chir forest type		Eir/Sprues in Fir/Sprus Forest type		Kail in B.P. Deodar Forest type		Deodar in Blue pine -Deodar forest type		Oak in oak forest type	
	Vol in M^3	Mean age	Vol in M^3	Mean age	Vol. in age	Age	Vol. in M^3	Mean age	vol. in M^3	Age
10-20	7.53	26	11.31	59	6.98	25	8.99	30	20.40	27
20-30	19.91	42	18.39	80	7.22	40	28.34	48	17.66	54
30-40	30.59	60	29.87	100	12.25	63	41.74	69	18.13	99
40-50	27.95	84	32.83	122	10.97	95	34.25	94.	19.46	-
50-60	21.89	128	28.63	143	5.92	-	27.16	132	20.07	-
60-70	8.87	-	25.12	163	1.79	-	20.06	199	16.09	-
70-80	3.18	-	14.56	190	1.40	-	10.87	-	14.32	-
80-90	1.05	-	17.22	218	1.45	-	3.76	-	8.55	-
90-100	.42	-	10.60	250	-	-	4.18	-	6.51	-
100-110	.43	-	8.21	-	-	-	2.09	-	4.00	-
+110	.0	-	5.86	-	-	-	2.93	-	3.43	-
Total	121.82	-	202.60	-	47.98	-	184.37	-	148.62	-

6. MEAN AGE OF THE CROP

The mean age for the important species such as Chir, Kail, Deodar, Fir/spruce and Oaks in Chir, Kail, Deodar fir-spruce and Oak forest type respectively has been worked out and is given in table No. V-5.

Table No. V-5

MEAN AGE OF THE CROP

Species	Diameter Class which has the maximum number of stems/hectare.	Diameter Class which has the maximum volume per hectare	Mean age of the crop.
Chir	10-20 cm.	30-40 cm	46 years
Kail	10-20 cm.	30-40 cm	40 "
Deodar	10-20 cm.	30-40 cm	60 "
Fir/Spruce	10-20 cm.	40-50 cm	93 "
Oak	10-20 cm.	50-60 cm	42 "

7. MEAN ANNUAL INCREMENT CALCULATED ON THE BASIS OF MEAN AGE AND VOLUME PER HECTARE

Mean Annual Increment for Chir, Kail, Deodar, Fir and Oaks in Chir, Bluepine-Deodar, Fir spruce and Oak forest types respectively on the basis of mean age of these species is approximated as under :-

Table No. V-6

MEAN ANNUAL INCREMENT

Species	Mean age	M.A.I. in Cubic metres/ hectare.
Chir	46 Years	2.65
Kail	40 "	1.20
Deodar	60 "	3.07
Fir/spruce	93 "	2.18
Oak	42 "	3.54

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8. PERIODICAL INCREMENT

Periodical increment for important species for the last 10 years and previous 10 years in basal area for different diameter classes has been worked out on the basis of the data of increment borings of sample trees. The annual increment percentage in basal area for Chir, Kail, Deodar and Fir/spruce is given below in table No. V-7

Table No. V-7

ANNUAL INCREMENT PERCENTAGE (BASAL AREA)

Dia. Class	Chir		Kail		Deodar		Fir/Spruce	
	for the last 10 years	for the previous 10 years	for the last 10 years	for the previous 10 years	for the last 10 years	for the previous 10 years	for the last 10 years	for the previous 10 years
10-20	3.52	4.88	2.84	4.20	3.57	3.54	1.73	2.01
20-30	2.81	3.53	2.74	3.44	2.46	2.94	1.85	1.61
30-40	2.35	2.79	2.22	2.69	1.96	2.34	1.58	1.5
40-50	1.86	2.13	1.70	1.98	1.66	1.93	1.30	1.3
50-60	1.44	1.60	1.26	1.41	1.46	1.59	1.06	1.1
60-70	1.06	1.16	0.92	1.09	1.29	1.33	0.88	0.9
70-80	0.81	0.90	0.73	1.00	1.14	1.11	0.74	0.8
80-90	0.68	0.74	0.61	0.77	1.00	0.90	0.62	0.6
90-100	0.59	0.63	0.54	0.68	0.87	0.71	0.53	0.6
100-110	0.52	0.55	-	-	0.74	0.52	0.45	0.4
110 +	-	-	-	-	0.61	0.35	0.39	0.3

9. VOLUME INCREMENT CALCULATED ON THE BASIS OF TREE INCREMENT

Growth percent in volume may be assumed as the growth percent in basal area. (Forest Inventory by H.R. SPURR, page 238). On this basis, volume increment of important species per hectare has been worked out taking into consideration the number of stems per hectare in each diameter class and is given in table No. V-8

Table No. V-8

VOLUME INCREMENT PER HECTARE OF IMPORTANT SPECIES - M^3

Dia.class	Chir		Kail		Deodar		Fir	
	For the last 10 years	for the previous 10 years	for the last 10 years	for the previous 10 years	for the last 10 years	for the previous 10 years	for the last 10 years	for the previous 10 years
10-20	0.250	0.357	0.198	0.293	0.321	0.318	0.196	0.227
20-30	0.559	0.703	0.198	0.248	0.697	0.833	0.340	0.296
30-40	0.719	0.853	0.272	0.329	0.819	0.976	0.472	0.466
40-50	0.520	0.595	0.185	0.217	0.568	0.661	0.427	0.437
50-60	0.315	0.350	0.075	0.083	0.395	0.432	0.304	0.325
60-70	0.094	0.103	0.015	0.019	0.259	0.274	0.221	0.239
70-80	0.026	0.028	0.010	0.014	0.124	0.120	0.108	0.118
80-90	0.007	0.008	0.009	0.011	0.038	0.034	0.107	0.117
90-100	0.002	0.002	-	-	0.035	0.030	0.066	0.072
100-110	0.002	0.002	-	-	0.015	0.010	0.037	0.039
110 +	0.000	0.000	-	-	0.018	0.010	0.023	0.023
Total	2.494	3.001	0.952	1.214	3.289	3.698	2.291	2.359

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10. MEAN ANNUAL INCREMENT

Mean annual increment for Chir, Kail, Deodar and Fir in Chir, Bluepine, Deodar and Fir_spruce forest types calculated on the basis of number stems per hectare and mean age has been compared with M.A.I. for the last 20 years obtained from sample tree data and is given in table No. V-9

Table No. V-9

MEAN ANNUAL INCREMENT OF IMPORTANT SPECIES - M^3

Species	Forest Type	M.A.I. per hectare for the last 20 yrs worked out on the basis of tree increment.	M.A.I. as calculated on the basis of number of stems per hectare and mean age
Chir	Chir	2.75	2.65
Kail	Bluepine Deodar	1.08	1.20
Deodar	Blue pine Deodar	3.49	3.07
Fir	Fir/spruce	2.33	2.18
Oak	Oak	-	3.54

Table No. V-9 shows that M.A.I. calculated for the last 20 years on the basis of tree increment data is slightly on higher side. The M.A.I. of Chir, Kail, Deodar and Fir compares well. To be on the safe side if is proposed to adopt the M.A.I. figures of different species as calculated on the basis of number of stems per hectare and mean age.

CHAPTER - VI

MANAGEMENT PRACTICES AND FUTURE PROPOSALS.

PRESENT MANAGEMENT PRACTICES :

1. The objectives of present management are generally to prevent soil erosion, help soil and moisture conservation by way of providing protective cover, to improve the quality and density of existing forest, to meet the demand of Local population and harvesting the safe maximum annual yield.

The forest under the control of the forest department are covered by regular working plans and are being managed scientifically. In commercial forests the fellings are carried out according to the prescriptions given under a silivicultural system. The interior and inaccessible areas are either allotted to unallotted working circle or protection working circle. The Chir forests are generally worked under uniform system by the method of floating periodic blocks. The rest of species are usually worked under some modified form of selection system. Natural regeneration is assumed to be the main source of regeneration. The yield is regulated by number of units or by number of trees arrived at by traditional yield formula. The minor forest products besides Resin, are also extracted in a planned manner.

The forests are being managed mainly with a view to produce large size timbers for railway sleepers and other constructional material. Broad Leaved species are generally managed for fuel. Exploitable diameter for Deodar, Kail, Fir and Spruce has been kept at 60 cm. The present management is not industrial oriented.

2. FUTURE PROPOSALS

The main objectives are :-

i) To meet the present and future demand of the existing industries and bonafide demand of local population.

ii) To provide raw material for proposed wood based industries.

Wooden railway sleepers may not be in demand for long time as better replacements are easily available. Therefore, the forests may not be managed for production of large size trees.

3. Our country needs news-print and other papers badly. Coniferous species such as Chir, Kail, Fir and Spruce are very suitable for production of high grade pulp which can be used for production of both newsprint and paper after mixing with mechanical pulp produced from Oaks and other hardwoods. Therefore, it is necessary that some of the forests may be managed with a view to setting up of pulp and paper industry to meet the requirement of the country and thus saving the valuable foreign exchange.

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For the manufacture of pulp and paper small size timber (upto 5 cm d.o.b.) can be used. It is, therefore, proposed that the Chir, Kail, Fir Spruce and other forests meant for producing pulp may be worked under shorter rotations. This would, of course involve perfection of regeneration techniques of all the species.

3. MANAGEMENT PRACTICES

Nothing rigid can be suggested in so far as the Siviculture system are concerned. The silviculture system to be adopted for the management of a particular species will depend upon a variety of factors such as objectives of the management, technique of regeneration, locality factors, etc. Silviculture system may therefore very from concentrated fellings to selection fellings.

4 INDUSTRIAL WOODS

Conifferous species such as Chir, Kail, Fir and spruce provide valuable long fibred raw material for production of pulp and paper. Chir and Kail trees exude resin which is also important for certain industries.

Broad leaved species are used for variety of purposes. Walnut and maple are good for manufacture of rifle-butts. Maple is also used for manufacture of shuttle blocks used in textile industry. Betula and Kharan are used for bobbin blocks. Most of the broad leaved species may be used for production of mechanical pulp. Oaks which form the bulk of growing stock may be managed for this purpose.

5 CUTTING MODEL

Two cutting models are considered. The objectives of these models are :-

MODEL I: Production of large size trees so as to meet the requirement of railway sleepers and other constructional timber, as in the present practice.

MODEL II: Production of raw material for pulp and paper and wooden packing cases up to 40 cm (at B.H.) trees are considered suitable for meeting these requirements.

6. SPECIFICATION FOR THE MODELS

The detailed specifications with regard to exploitable diameter for different species in respect to these two models are summarised below :-

Table No. VI-1

EXPLOITABLE DIAMETER FOR DIFFERENT MODELS

Species.	MODEL I Exploitable Diameter cm.	MODEL II Exploitable diameter Cm.
Chir	60	40
Kail	60	40
Deodar	60	40
Fir/Spruce	60	40
Oaks	40	30

7. ANNUAL CUT

The annual cut is a function of growing stock, rotation, rate of growth, management practices and several other important factors. These factors are being examined in subsequent paragraphs.

8 GROWING STOCK

The gross and net growing stock of important species is given in table No. IV-6 and is reproduced as under :-

Table No. VI-2

GROWING STOCK - GROSS & NET

Species	Volume in 000 cubic metres Gross	Net (after deduction of cull)
Chir	15658.4	15658.4
Kail	1443.4	1371.2
Deodar	4338.4	4338.4
Fir & Spruce	7074.9	5659.9
Oaks	28421.1	22065.8
Others	13142.8	13142.8
Total	71079.0	62236.5

9. RATE OF GROWTH

The Mean Annual Increment of important species such as Chir, Kail, Deodar, Fir/Spruce, Oaks in Chir, Bluepine, deodar, fir-spruce and oak forest type respectively has been worked out and is given in table No. V-6 which is reproduced below :-

Table No. VI - 3

MEAN ANNUAL INCREMENT

Species	Mean Annual Increment in Cubic metres per hectare
Chir	2.65
Kail	1.20
Deodar	3.07
Fir/spruce	2.18
Oak	3.54

10. ROTATION

For production of required size of timber under the two cutting models as described in paragraph II. The rotation for different species has been worked out as under.

11. CUTTING MODEL I

Approximate age for production of large size timber aimed in cutting model I and proposed rotation has been given in table No. VI-4

Table No. VI-4

ROTATION FOR CUTTING MODEL I

Species	Approximate age for production of big size timber (60 cm)	Proposed rotation in years.
Chir	125	120
Kail	150	150
Deodar	155	150
Fir/spruce	155	150
Oak	120 (40 cm)	120

12 CUTTING MODEL II

The need to produce wood for setting up of pulp and paper industry requires change in management at least in certain areas. Trees of 30 cm diameter (at B.H.O.B.) are considered good enough for pulp and paper industry. Besides meeting the requirement of pulp and paper industry the model also aims at producing trees for fruit packing cases. Trees with 40 cm. diameter at B.H. (O.B) may provide sufficient material to satisfy the demand for fruit packing cases. The age of different species to obtain 40 cm. diameter a long with the possible rotation has been worked out as under :-

Table No. VI - 5

Species	Age to obtain 40 cm. L.B.H (years)	Possible rotation (years)
Chir	65	65
Kail	80	80
Deodar	80	80
Fir/spruce	110	100
Oak	100 (30 cm)	100

13. ANNUAL YIELD

Annual yield for different species will be regulated by the following formula in both the models :-

$$\text{Annual yield} = \frac{\text{Total growing stock (net)}}{\text{Rotation}} + \frac{\frac{1}{2}\ \text{M.A.I. of the forest type}}{\text{Rotation}}$$

14. ANNUAL CUT

Annual cut for different species under the proposed two models is worked out and is given in table No. VI-6

Table No. VI-6

Species	Annual cut in cubic metres	
	MODEL I	MODEL II
Chir	2,02,000	4,03,000
Bluepine	22,000	30,000
Deodar	61,000	87,000
Fir/spruce	61,000	80,000
Oak	4,83,000	5,20,000

The annual cut for lowland hard woods and upland hardwood has not been calculated. These species may continue to be managed as per current management practices to meet the requirement of local population and certain small scale Industries.

CHAPTER - VII

MARKET AND DEMAND STUDIES

1. OBJECTIVE:

Market & Demand Studies were undertaken in the area. The main objectives of these studies were :-

1) To work out the present (1972-73) level of wood production in the area.

2) To prepare an account of wood consumption by various category of users for the year 1972-73.

3) To survey the present status of timber markets of the area indicating the prices of different species.

4. To forecast the level of wood consumption for the year 1981 & 1991.

2. SOURCES OF INFORMATION

Information regarding infrastructure has been collected from census of 1971 and other Government records and have been quoted at relevant places.

3. (ii) Information regarding production of wood has been collected for the last 6 years i.e. (1966-67 to 1971-72) from the records of Forest Department. The figures thus collected were converted to W.R.E. and averaged to work out average annual production.

(iii) Information regarding import and export and supplies to Government Departments have been collected from the records of Forest Department and other Departments. These figures were also converted to W.R.E.

(iv) A complete survey of all Wood Based Industries of the Zone has been carried out to work out the consumption of wood by these industries.

(v) Local consumption of wood for house construction and repairs, agricultural implements and fuel has been worked out from the low intensity sample survey and available records.

(vi) The following conversion factors have been used in this report.

one M^3 WRE	= 0.5 Cubic metres of Sawn
One M^3	= 35.31 cubic feet
One Cft.	= 0.028 Cubic metres
One Maunds (Fuel)	= 3 cft.
One Metric Ton Fuel	= 1.5 M^3 WRE.
One ton of charcoal	= 5.208 M^3 WRE

3. PRODUCTION OF WOOD

The production of wood has been assessed from the Govt. Forests and also from the private and Revenue Forests.

4. FROM GOVERNMENT FORESTS BY LESSEE

The wood from the Government Forests, is removed by lessees, Departmental Agencies and by right holders and concessionists. The wood removed by this agency is mostly in the form of sleepers. Some timber is also removed in the shape of Hakaries & Gola. The following table shows the average annual production which has been worked out by averaging figures of 6 years (i.e. 1966-67) to 1971-72).

The actual production in the area has been worked out by proportionately reducing the figures of the different Forest Divisions according to the area included in the survey.

Table No. VII - 1

AVERAGE ANNUAL PRODUCTION THROUGH LESSEE - M^3
FROM 1966-67 TO 1971-72

Name of Div.	TIMBER Chir	Kail	Deodar	Fir/Spr.	Others		FUEL Semi-fire.	B.L.	T
Chakrata	2900.88	2606.57	4157.38	20489.00	56.70.	[illegible]	-	378.48	37[illegible]
Tons	2081.23	567.98	3020.08	939.62	-	[illegible]	-	-	-
Yamuna	31807.96	4869.79	1323.00	5654.96	1155.24	[illegible]	-	-	-
Uttar Kashi	124683.20	526.06	683.95	39307.84	230.33	[illegible]	[illegible]	5703.07	63
Tehri F.D.	23394.16	-	91.16	738.25	1459.25	[illegible]	-	2658.17	2[illegible]
LOGGING Div.	8330.01	-	-	-	-	8330.01	[illegible]	-	38[illegible]
Chakrata Cant FD.	0.67	8.01	31.21	-	76.81	[illegible]	-	-	-
GRAND TOTAL	193198.11	8578.41	9306.78	67130.47	2978.33	281192[illegible]	[illegible]041.97	8739.72	97[illegible]

5. DEPARTMENTAL EXTRACTION

Departmental extraction is done on a small scale. This is, generally done to meet the internal demand of the department for the construction of buildings and bridges. The Table No. VIII-2 shows the quantity of timber and fuel wood extracted departmentally in the area. With the creation of U.P. Forest Corporation the entire extraction will be nationalised gradually

Table No. VII - 2

AVERAGE ANNUAL PRODUCTION FROM - M^3
1966-67 to 71-72

Name of Division	TIMBER						FUEL		
	Chir	Kail	Deodar	Fir/ Spruce	Others	Total	Coni-fers	B.L.	Tot
Chakrata Forest Division.	37.33	4.99	22.13	0.95	43.70	109.10	-	-	-
Tons Forest Division	212.15	45.13	63.09	47.67	0.89	368.93	-	-	-
Yamuna Forest Division.	169.06	165.16	41.40	6.03	16.92	398.57	-	-	-
Uttarkashi Forest Division	3783.44	4.29	39.91	36.73	15.41	3879.78	-	0.20	0.2
Tehri Forest Division	396.67	-	25.67	2.83	260.33	685.50	-	-	-
Total	4598.65	219.57	192.20	94.21	337.25	5441.88	-	0.20	- 0.2

6. BY RIGHT HOLDERS AND CONCESSIONISTS

The local population enjoys certain concessions to obtain their bonafide requirements of timber and fuel wood from the forests of the area. Rural population is completely dependent upon the forest for their wood requirements. A large quantity of wood is being removed by them. The timber for the construction and repair of the houses and for agricultural implements is generally given to right holders and a record is maintained in the Divisional Forest Office. However, certain quantity is also removed illegally and there is no record for such removals. Fuel wood is generally removed free of cost and there is no record for the total removals. The following is the recorded quantity of timber and fuel wood removed by right holders and concessionists.

Table No. VII-3

ANNUAL REMOVALS THROUGH RIGHT HOLDERS & CONCESSIONISTS FROM 1966-67 to 1971-72

Unit-Cubic metres

Name of the Chir Division	TIMBER								
	Chir	Kail	Deodar	Fir/ Spruce	Other	Total	Bond-Fide	B.L.	Total
Chakrata F.D.	839.29	237.93	522.44	90.78	36.45	1726.89			
Tons F.D.	92.65	469.67	-	263.20	2.19	827.71	-		
Yamuna F.D.	1941.15	77.89	71.44	47.43	155.63	2292.54	-	5440.05	5440.05
Uttarkashi F.D.	5643.27	276.27	695.79	722.92	307.16	7645.41	-	24.78	24.78
Tehri F.D.	9439.33	2.66	8.00	842.50	1072.33	11364.82	-	-	-
GRAND TOTAL	18955.69	1064.42	1292.67	2066.83	1579.76	24961.37	-	5464.83	5464.83

7. PRODUCTION FROM REVENUE FORESTS

The total production from Revenue and Private Forests is 2260.56 cubic metres. The fellings in the Revenue Forests is not carried out on any systematic pattern. On the basis of available records the quantity of wood removed from Revenue Forests is given in Table No. VII-4 It has been observed that there is no volume to be available from Revenue Forests in Chakrata & Tons Forest Division.

Table No. VII-4

AVERAGE ANNUAL PRODUCTION FROM 1966-67 to 71-72

Unit-Cubic metres

Name of Division	Chir	Kail	Deodar	Fir/ Spruce	Other	Total	Fuel wood
Chakrata	-	-	-	No data	-	-	
Tons	-	-	-	No data	-	-	
Yamuna	649.60	-	4.83	-	-	654.43	
Uttarkashi	793.56	1.96	14.00	-	-	809.52	
Tehri	780.56	-	16.05	-	-	796.61	
TOTAL	2223.72	1.96	34.88	-	-	2260.56	-

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8. PRODUCTION FROM PRIVATE FORESTS

Rural population removes certain quantity of wood growing on their own lands. Whenever the trees are to be cut from private lands, a permission is required from Deputy Commissioner and permit for transport for such felled material is issued by Divisional Forest Officer.

The quantity of wood removed from private lands as per records is given in Table No. VII-5

Table No. VII-5

Unit-Cubic metres

Name of Division	TIMBER						FUEL		
	Chir	Kail	Deodar	Fir/ Spruce	Other	Total	Coni-fers	B.L.	Tot-
Chakrata	278.36	226.72	283.97	-	-	789.05	-	-	-
Tons	1950.32	15.00	-	-	-	1965.32	-	-	-
Yamuna	772.73	10.17	31.64	-	-	814.54	-	104.16	104.1
Uttarkashi F.	1072.67	480.33	94.76	31.59	2.40	1681.75	-	-	-
Tehri	649.29	-	-	-	-	649.29	-	-	-
TOTAL	4723.37	732.22	410.37	31.59	2.40	5899.95	-	104.16	104.

9. TOTAL PRODUCTION

Average annual production of timber and fuelwood from the area is given in Table No. VII-6. Average annual production of timber and fuelwood is 3,18,712.86 m^3 respectively.

Table No. VII.3

Total [illegible] from the Zone

Source	[illegible]	[illegible]	[illegible]	[illegible]	Others	Total	Unit - Cubic meters Fuel Wood	Coniferous B.L.	TOTAL
A. GOVT. FORESTS									
(i) Through Lessees	1[illegible]198.11	8570.41	[illegible]	67[illegible]	[illegible]	[illegible]	1041.97	8739.72	9781.69
(ii) Through Deputy Agency.	[illegible]	219.57	[illegible]	94.21	337.25	5441.[illegible]	-	0.20	0.20
(iii) Right Holders Concessionaires	17955.69	1064.42	1297.67	2026.83	1573.75	23918.37	-	5465.28	5465.28
TOTAL (A)	215752.45	9862.40	10796.65	69251.51	4899.84	310552.35	1041.97	14205.20	15247.17
B. RESERVE FOREST	2223.72	1.96	34.88	-	-	2260.56	-	-	-
C. PRIVATE LANDS	4723.37	732.22	410.37	31.59	[illegible]	5899.94	-	104.16	104.16
TOTAL (B + C)	[illegible]	734.18	445.25	31.59	2.40	8160.51	-	104.16	104.16
GRAND TOTAL (TOTAL A+B+C)	222[illegible].54	10596.58	11241.90	69283.10	4891.74	318712.86	1041.97	14309.36	15351.33

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WOOD CONSUMPTION

10. CONSUMPTION OF WOOD

The following category of wood users have been recognised:

1) Local population for

i) House construction & repairs.
ii) Agricultural implements.
iii) Fuel
iv) Other domestic uses.

2) Industries and departments

i) Furniture industry
ii) Packing case industry
iii) Hydel projects.
iv) Other departments

3) Export

i) D. G. S. & B.

ii) Railways
iii) Timber Market.

11. CONSUMPTION OF WOOD BY LOCAL POPULATION

The area extends from an elevation of 600 metres to 5,000 metres and more. The winter is generally very serere and snow fall is quite frequent in areas which are more than 2,000 metres in altitude. The climatic condition have a direct impact on house pattern and use of wood for fuel.

12. WOOD CONSUMPTION FOR HOUSE CONSTRUCTION & REPAIRS

80 houses were surveyed in the area and it has been observed that villagers generally live in two storeyed houses. The ground storey is used for their cattle and the upper storey is used for residence.

The study has also revealed that timber requirement for house construction and repairs was almost double in the rural areas of Uttarkashi District and Chakrata Tehisl of Dehradun District as compared to rural areas of Tehri District. Therefore, the consupption of the wood for house construction and repairs for these two areas has been worked out separately.

13. UTTARKASHI AND DEHRADUN DISTRICTS

The analysis of data obtained from sample Survey has revealed that the quantity of wood consumption of construction of a house in this area is 24.00 m^3 per house. As per 1971 census there are 41999 houses as against 37082 houses in the year 1961. This shows that 492 new houses were constructed annually.

The average life of a house was found to be 100 years from the survey and repair is done at 10 years interval. This means that 10% of the houses will need repairs each year. The quantity of timber required for repair is 10% of the quantity required for construction of a new house.

The consumption of wood for the construction of new houses and repairs been worked out for the year 1972-73 on the basis of timber of houses in 1971. It is assumed that the consumption for 1972-73 would be the same as in 1971 and is given in table No. VII - 7

Table No. VII - 7

WOOD CONSUMPTION FOR HOUSE CONSTRUCTION & REPAIRS

S.No.	Item	No. of houses	Quantity of timber required for one house m^3	Total Consumption m^3
1.	Construction of new houses	492	24.00	11,808.00
2.	Repairs	4200	2.4	10,080.00
TOTAL				21,888.00

14. TEHRI DISTRICT

Sample Survey has revealed that 13.00 cubic metres of timber is required for construction of a house in Tehri District According to 1971 census there are 74658 houses in Tehri District as against 73382 in 1961. The number of new houses which are being constructed annually comes to 228. The life of a house is about 100 years and repair interval about 10 years, and quantity of wood required for repair is 10% of the quantity required for the construction of a new house. The consumption of timber for house construction and repairs in the Tehri District has been worked out and is given in Table No. VII-8

Table No. VII - 8

WOOD CONSUMPTION FOR HOUSE CONSTRUCTION AND REPAIRS IN THE [illegible]

S.No.	Item	No. of houses	Quantity of timber required in m^3	Total consumption in m^3
1.	Construction of new houses	228	13.00	2,964.00
2.	Repair of old houses	7466	1.30	9,705.80
	TOTAL			12,669.80

Urban population constitutes only 6.5% of the total population in the area. Therefore, separate estimates for urban houses have not been made.

15. TOTAL CONSUMPTION

Total Annual consumption of timber for house construction and repairs for the area is 34,357.80 m^3. Sample Survey has revealed that the percentage of use of Chir, Kail, Deodar, Broad Leaved species was 50%, 8%, 30% & 12% respectively. Therefore, the quantity in m^3 of different species works out as under :

Chir	Kail	Deodar	B.L.	Total
17,278.90	2,764.62	10367.34	4146.94	34,357.80

16. WOOD CONSUMPTION FOR AGRICULTURAL IMPLEMENTS

Agricultural implements such as ploughs, levellers, etc. are made of wood and a sizeable quantity of timber is used for this purpose.

Sample survey of 80 houses in the rural area has revealed that on an average there is one plough in each house-hold. One leveller is required between the two house-holds. The life of a plough and leveller is found to be one and two years respectively. There are 70535 house-holds engaged in cultivation. The number of ploughs and levellers and the quantity of timber required for these purposes are given in table No. VII-9 /hold. It has been further revealed that leveller is not

Table No. VII -9

1. WOOD CONSUMPTION FOR AGRICULTURAL IMPLEMENTS

S.No.	Item	Number required per year	Approximate requirement of timber for one unit in M^3	Total timber requirement in m^3
1.	Plough	79535	0.14	11134.90
2.	Leveller	39767	0.15	5965.05
GRAND TOTAL				17099.95

Sample Survey has revealed that percentage use of Chir, Deodar and Broad Leaved species is 15% & 80% respectively. Therefore, the quantity of these species comes to 2565.00 855.00 and 13679.95 m^3 respectively.

17. CONSUMPTION OF WOOD FOR FUEL

Area with a predominantly rural population depends upon local materials for the use of fuel wood. The most common fuels used in the area are fire wood, vegetable waste and cow dung. In urban areas charcoal, Kerosene, Gas or even electricity are used besides the use of firewood.

The consumption of firewood is definitely more in rural areas than in the urban areas. The quantity of consumption has, therefore, been worked out separately for rural and urban areas.

18. FUEL CONSUMPTION FOR RURAL AREAS

The per capita consumption of firewood for whole of the country has been estimated to be 235.00kg. per year by N.C.A.E.R., New Delhi. (" Domestic fuels consumption in rural India " page 81 by National Council of Applied Economic Research, New Delhi).

The sample survey conducted for finding out fuel consumption in the area has revealed that per capita consumption of fire wood comes to 693.5 kg. per year. The higher figures of consumption are explainable because of cold climatic conditions in the area. The total quantity of fire wood consumption for rural areas has been worked out as follows :-

Per capita consumption	=	693.5 kg. per year
Total population, 1971	=	601670
Total consumption	=	693.5 x 601670

19. FUEL CONSUMPTION IN URBAN AREAS

According to sample survey per capita consumption in urban areas is 522 Kg. per year. The total quantity, therefore, works out to be :-

Per Capita consumption	=	522 Kg.
Total urban population	=	43037
Total Consumption	=	22465.31 Tonnes/year

TOTAL WOOD CONSUMPTION FOR FUEL

S.No.	Area	Total Consumption in Tonnes.	Total consumption in m³
1.	Rural	4,17,258.13	6,25,887.23
2.	Urban	22,465.31	33,697.97
	Total	4,39,723.46	6,59,585.20

Broad leaved species are generally used for firewood. The proportion, therefore, has been adopted as 80% and 20% for broad leaved and coniferous respectively and works out to be as under :-

B.L.	=	5,27,668.16	Cubic metres
Coniferous	=	1,31,917.04	" "
Total	=	6,59,585.20	" "

20. The supply of fuel wood is largely met from Government forests and balance from private forests. Large quantity comes from the forest in the forms of lops and tops, dead & diseased trees. Some quantity is obtained from farm forests, revenue forests and private holdings. No record is available for removal of total fire-wood from forests. As such whole quantity of fire wood consumed is not debitable to the total consumption for working out the wood surplus. The recorded quantity of fuel wood which is given below may however, be debited for working out the wood balances.

RECORDED QUANTITY OF FIRE WOOD

1. Coniferous = 1041.97 m^3

2. Broad leaved = 14,309.36 m^3

The quanity of coniferous fuel wood is divided on the basis of production pattern under Chir, Kail, Deodar & Fir/spruce as 60%, 5%, 10% and 25% respectively. The quantity of different species in m^3 works out to be as under :-

Chir	Kail	Deodar	Fir/Spruce	B.L.	Total
625.18	78.15	78.15	260.49	14,309.36	15,351.37

21 WOOD CONSUMPTION FOR OTHER DOMESTIC USES

Quite a sizeable quantity of timber is used for domestic purposes such as costs, tools, handles etc. No data was collected for the consumption of wood for this purpose. Taking into consideration the life and number of such items it is assumed that per capita consumption of timber for this purpose works out to be 6.44707 x 0.01 = 6447 m^3. Chir, and Broad leaved species are generally used for this purpose. Asuming the percentage of each species as 50, the quantity of Chir and Broad leaved species works out to be 3223.50 m^3, and 3223.50 m^3 respectively.

22. WOOD CONSUMPTION BY INDUSTRIES

SAW MILLING

In-spite of huge forest wealth, saw milling industry has not developed mainly because of poor transport communications and absence of any major wood based industry. Total survey of saw mills was carried out. There are 21 saw mills situated in the area.

The timber for sawing comes both from Government and Private Forests (Soyam Forests). Table No. VII - 10 gives the total and species wise treak up converted in the saw mills.

Table No. VII - 10

TOTAL INTAKE OF SAW MILLS

Unit - Cubic metres

Source	Chir	Kail	Deodar	Fir	B.L.	Total
Government Forests.	3653.60	60.00	160.00	-	19.24	3992.84
Other source (Soyam Forest)	1434.64	291.66	241.92	16.00	413.60	2397.82
Total	5188.24	351.66	401.92	16.00	432.84	6390.66

A saw mill itself is not a wood consuming industry. The sawn wood is generally disposed for the following purposes :-

i) House construction and repairs.

ii) Furniture industry.

iii) Walking-stick industry.

iv) Fruit packing case industry.

23. FURNITURE & WALKING STICK INDUSTRY

Total survey of furniture & walking-stick making industries was carried out. There are 21 such units in the area. The total consumption of timber by these units has been found after contacting owners of each unit.

The total consumption works out to 673 cubic metres. Out of this 90 cubic metres of timber, mostly teak (Tectona grandis) and sissoo (Dalbergia sisoo) are imported by furniture makers. The species wise break up is given below :-

(a)	Import (Teak & Sissoo)	=	90.00	m^3
(b)	Deodar	=	325.00	"
(c)	Kail	=	70.00	"
(d)	Chir	=	70.00	"
(e)	Other broad leaved	=	118.00	"
	Total		673.00	"

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24. WOOD CONSUMPTION BY FRUIT PACKING CASE INDUSTRY

The situation and climate of the area make it suitable for the development of horticulture. A fruit growing belt is being developed in btween Chakrata and Mussoorie and Mussoorie to Chamba. In Uttarkashi region large areas are being brought under fruit cultivation. The total areas under orchards at present is 26000 hectares. 80% of this is under apple cultivation. Taking an average yield of 1.5 tonnes per hectare, the total production of furuits during 1972-73 works out to be 39.000 tonnes or 19.50,000 boxes (20 Kg. each).

The requirement of timber for this purpose is 33,150 cubic metres. (Taking one box = 0.017 cubic metres of WOOD). There are no sufficient number of units for supplying these packing cases. Table No. VII-10 shows that only 6390.66 cubic metres are sawn in the saw mills and sawn material is supplied not only to packing case industry but for other purposes also. The demand is being met from Dehradun and Vikashnagar. The most common timber used is Chir which forms about 80% of the total requirement. The other species used is fir. The quantity of Chir and Fir, therefore, works out to be as 26,520.00 and 6630.00 m^3 respectively.

25. WOOD CONSUMPTION BY HYDEL PROJECTS

There are two main hydel projects in the area. They are Manery hydel projects located near Uttarkashi and Tehri Dam Project located near Tehri. Under Tehri Dam project there is another Dam being constructed at Rishikesh. The wood requirement for these Projects is mainly for building works. The annual requirement for these projects is given in Table No. VII-11.

Table No. VII-11

WOOD CONSUMPTION BY HYDEL PROJECTS

Name of the Project		Annual requirement of timber in m^3		
		Deodar	Sal	Total
(i)	Manery Dam Project	2400.00	-	2400.00
(ii)	Tehri Dam Project	4300.00	5940	10240
(iii)	Rishikesh Dam Project	2208.00	1869	4077
	Total	8908.00	7809	16717.00

Source : Office of the Tehri Dam Division, IV, Dehradun.

26. CONSUMPTION BY OTHER DEPARTMENTS

Some quantity of wood is also supplied to certain Govt. Departments and Institutions from the area. The figures for the period 1966-67 and '71-72 have been collected and averaged to work out average annual supply. The year-wise and species-wise supply is shown in Table No. VII-12.

Table No. VII- 12

Supplies to other Departments

(Average Annual consumption from 1966-67 to 71-72)

Unit - Cubic Metre

Year	Chir	Kail	Deodar	Fir/Spruce	Others	Total
1966-67	38.792	9.072	12.380	-	3.904	64.148
1967-68	36.622	1.456	40.604	-	0.128	78.810
1968-69	41.643	-	0.014	0.017	0.424	42.098
1969-70	64.590	3.416	18.794	-	9.954	96.754
1970-71	2538.34	-	0.016	-	124.840	2663.196
1971-72	401.272	-	18.506	-	0.308	420.086
Total	3121.259	13.944	90.314	0.017	139.558	3365.092
Average	520.21	2.32	15.05	0.02	23.26	560.86

27. EXPORT OF TIMBER OUTSIDE THE AREA :

Export of the timber from the area comprises the supplies to the following :

(a) Railways
(b) D.G.S. & D.
(c) Timber markets.

28. SUPPLIES TO RAILWAYS :

The supply made from the year 1966-67 to '71-72 has been collected and averaged to find out the average annual supply. The timber supplied to railways is in the form of sleepers. The year-wise and species-wise supplies made to railways are shown in Table No. VII-13

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Table No. VII - 13

AVERAGE ANNUAL SUPPLY OF TIMBER TO THE RAILWAYS FROM THE AREA

Unit - Cubic Metres

Year	Chir	Kail	Deodar	Fir/Spruce	Other	total
1966-67	26,814.035	-	1,382.585	7,589.981	-	35,795.601
1968-69	23,227.970	44.207	1,468.396	1,312.226	-	26,052.799
1969-70	28,624.595	-	436.212	4,524.968	-	33,585.775
1970-71	18,439.201	68.990	309.840	690.654	-	19,508.685
1971-72	16,426.828	98.620	231.560	2,284.892	-	19,041.900
Total	1,13,532.629	211.817	8,828.593	16,411.721	-	1,33,984.760
Average	22,706.53	42.36	765.70	3,282.34	-	26,796.95

29. SUPPLIES TO D.G.S. & D.

The supply figures to D.G.S. & D. from the year 1966-67 to 1971-72 have been collected and averaged to work out the average annual supply. The supply is mostly in the form of sleepers. The species wise and year wise figures are given in the Table No. VII-14.

Table No. VII - 14

AVERAGE ANNUAL SUPPLY TO D.G.S. & D.

Unit- Cubic Metres

Year	Chir	Kail	Deodar	Fir/ Spruce	Total
1966-67	4,983.177	-	-	3,937.134	8,920.311
1967-68	1,496.150	-	56.030	6,694.265	8,246.445
1968-69	1,490.604	-	1,480.773	2,248.326	5,219.703
1969-70	-	345.040	271.546	1,988.210	2,604.796
1970-71	1,199.078	-	1,682.190	19,022.403	21,903.671
1971-72	5,505.554	-	2,779.100	5,258.440	13,563.094
Total	14,674.563	354.040	6,289.639	39,148.778	60,458.020
Average	2,445.76	57.51	1,048.27	6,524.80	10,076.34

30. SUPPLY TO TIMBER MARKETS

Most of the timber extracted from the Government Forests by Lessees are marketed in the timber markets of Yamuna Nagar, Dehradun and other markets of plains.

Efforts have been made to collect figures of wood marketed at Yamuna Nagar, Dehradun, Raiwala etc. by collecting informations from check posts and collecting informations from the B-9 registers of the Forest Divisions. The figures have been collected for the last 5 years and averaged. Average annual export to the timber markets is given in the table No. VII-15.

Table No. VII - 15

Unit - Cubic metre

S.No.	Division	Chir	Kail	Deodar	Fir/ Spruce	Others	Total
1.	Chakarata	1524.00	2663.87	5008.67	1296.00	77.42	10569.96
2.	Tons	19211.18	5271.74	34174.68	45263.90	33.02	103954.52
3.	Yamuna	33359.95	4412.32	785.46	2367.53	1052.31	41977.57
4.	Uttarkashi	3973.67	547.49	235.14	1168.63	7.77	5932.70
5.	Tehri	46788.33	182.33	1476.50	2918.50	1672.41	53038.07
6.	Logging Division	5547.80	-	-	-	-	5547.80
	Total	110404.93	13077.75	41680.45	53014.56	2842.93	221020.62

Note :- These figures include export for whole of the area of Tons, Tehri Yamuna, Uttar Kashi and Chakrata Forest Divisions. The actual figures of export from the area could not be worked out.

31. Average annual consumption for the year 1972-73 has been summarised in Table No. VII - 16

Table No. VII - 16

SUMMARY WOOD CONSUMPTION IN THE ZONE IN THE YEAR 1972-73

S.No.	Item	SPECIES Chir	Kail	Deodar	Fir/ Spruce	B.L.	Total
1.	House Construction & repairs.	17278.90	2764.62	10367.34	-	4146.94	34557.80
2.	Agricultural Implements.	2565.00	-	855.00	-	13679.95	17099.95
3.	Fuel (Recroded)	625.18	78.15	78.15	260.49	14309.36	15351.33
4.	Other domestic uses.	3223.50	-	-	-	3223.50	6447.00
5.	Industries:						
	(a) Furniture Industry	70.00	70.00	325.00	-	118.00	583.00
	(b) Packing case	26520.00	-	-	6630.00	-	33150.00
	(c) Hydel Projects	-	-	8908.00	-	7809.00	16717.00
	(d) Other Department	520.21	2.32	15.05	-	23.26	560.84
Total internal consumption		50802.79	2915.09	20548.54	6890.49	43310.01	124466.92
(i) Railways		22706.53	42.36	765.72	3282.34	-	26796.95
(ii) D.G.S.&D.		2445.76	57.51	1048.27	6524 .82	-	10076.34
Total of committed export		25152.29	99.87	1813.99	9807.14	-	36873.29
GRAND TOTAL		75955.08	3014.96	22362.53	16697.63	43310.01	161340.21
Or Say		75955	3015	22363	16698	43310	161341

32. TIMBER MARKET

There are no important Timber Markets in the area. Timber extracted by lessess from the area is mostly exported to markets of Dehradun, Yamuna Nagar, Raiwala etc.

The rates of different species at Raiwala and Yamuna Nagar have been collected which are given below :-

Raiwala (Data of collection 29.9.73)

Description of Timber		Sizes		Rate per Cft.
Logs	Spp.	Girth	Length	
(a)	Deodar	4' & above	10' to 12'	Rs. 15/- to 16/-
		3' - 4'	"	Rs. 14/- to 15/-
(b)	Kail	4' & above	10' to 12'	Rs. 11.50 to 12.50

Sawn Timber

			Deodar	Kail	Chir	Fir
Deodar	10'-12'	x10"x5"	Rs. 18-50	15.50	11.50	10.50
	6'-8'	x10"x5"	Rs. 15.50	12.50	9.50	9.50
	10'-12'	x8"x5"	Rs.15.50	12.50	9.50	9.50
	10'-12'	x6"x4"	Rs.14.00	11.00	11.00	9.50
	6 '-8'	x6"x4"	Rs.12.50	9.00	8.00	8.00
	Girth	Length				
Poles	15"-24"	10'-12'	Rs. 1.10	1.00	1.00	1.00
Ballies	Below	15" Girth	0.55	0.50	0.50	0.50
Hakries	Rs. 10 per Hakrie.					

Yamuna Nagar (25.9.73)

Sleeper	Spp.		
"	Deodar	10' x 10" x 5"	Rs. 65 to 68 each
"	"	8' x 10" x 5"	Rs. 17/- per Cft.
"	"	10' x 8" x 5"	Rs. 48.47/- each
Axe Cut Hakris.		12' x 6" x 6"	Rs. 13.50 per Cft.
		10' x 6" x 6"	Rs. 13.50 per Cft.
		12' x 5" x 5"	Rs. 14.50 per Cft.
Sleeper	Kail	12' x 10" x 5"	Rs. 65/- to 68/- each
"	"	10' x 10" x 5"	Rs. 62/- to 58/- each.
"	"	12' x 8" x 5"	Rs. 48.47/- 45/- each.
"	"	10' x 8" x 5"	Rs. 38/- 30/-40/- each
Hakries	"	12' x 6" x 6"	Rs. 11/- per Cft.
Sleeper	Fir	12' x 10" x 5"	Rs. 11/- to 11.50 per Cft.
"	"	10' x 10" x 5"	
"	"	12' x 8" x 5"	Rs. 10.50 per Cft.
"	"	10' x 8" x 5"	
"	Chir	12' x 10" x 5"	Rs. 12/- to 12.50 per Cft.
"	"	10' x 10" x 5"	
"	"	12' x 6" x 6"	Rs. 9.50/- per Cft.
"	"	10' x 8" x 8"	

(In these markets the metric system was still not in vogue during 1973 hence British measures have been used).

33. FORECAST OF FUTURE DEMAND :

The future demand of wood is governed by various factors such as growth in population, changes in income structure, literacy, price trend of various commodities, change in technology, literacy, availability of substitutes, consumer preferences etc. The analysis of these factors will give an indication of future demand of timber in the area.

Various techniques for projecting future demand are available. A task Force operating under the aegis of the National Commission on Agriculture have projected the demand of Forest products for the country in the years 1980 and 1990 which is given in Table No. VII - 17.

Table No. VII - 17

Projection of India's Industrial wood requirement 1980-90

(Thousand m^3 per annum)

	1980			1990		
	Conifers	Hard woods	Total	Conifers	Hard woods	Total
Pulp wood	1555	3478	5033	4461	8271	12732
Sawn wood & sleeper	1816	10836	12652	2395	14605	17000
Round wood	1385	5542	6927	1887	7549	9436
Panels	189	755	944	281	1126	1407
Total Industrial wood	4945	20611	25556	9024	31551	40575

Source : National Commission on Agriculture Interim report on production-Forestry Ministry of Agriculture 1972-P -30.

The techniques available for such forescastings generally suffer from the one defect or the other. However, the factors such as population growth, income structure, price trend etc. are assessed and future forecasts are made. The effect of important factors on demand is discussed.

The effect of population upon consumption is generally assumed to be uniform and quantitative relationship of income and consumption of wood products has indicated a positive co-relation through out the world. Higher the level of per capita income, higher will be the per capita consumption of sawn wood at least upto a certain level. Such relationship is represented by Elasticity Co-efficient for income which is given below :-

$$\text{Income-Elasticity Co-Efficient} = \frac{\%\ \text{Change in quantity consumed}}{\%\ \text{Change in income}}$$

Price is another important variable. Any realistic forecast should mention at what price level the forecast is tenable. The relationship between demand and price is called price elasticity of demand. Where production is a fixed quantity and the costs are stationary, a rise in basic demand caused by increase in population or in the standard of living would tend to raise the market price vertically. At such stages substitutes are preferred.

The other factors which affect the demand are changes in technology, consumer preferences, literacy etc. which are difficult to evaluate and are beyond the scope of this study.

It is proposed to project the demand of wood in the area for the year 1981 and 1991.

34. POPULATION ESTIMATES :

The population of the area according to 1971 census is 8,44,707 as against 5,95,658 in 1961. The population for the year 1981 and 1991 have been projected by the following formula :

$$Pn = Po\ (1+r/100)^n$$

Where Pn = Population in n th year

Po = Population in the base year

r = rate of growth per annuam.

The population for the year 1981 and 1991 works out to be as under :-

Population in 1981 = 10,50,200
Population in 1991 = 17,10,700

35. INCOME ESTIMATES :

From the available figures, the per capita income of whole U.P. for the year 1961 is 245.00 and for 1971 is Rs.275.00 at 1960-61 price level. The same income figures have been adopted for the area.

The income growth per year from 1961 to 1971 works out to be 3%. In view of the developmental activities under 4th, 5th and 6th plans, it is assumed that income growth per year from 1971 to 1981 would be 7.5% per year and 10% from the year 1981 to 1991. Therefore, per capita income for the year 1981 and 1991 works out as under :

Per capita income in 1981	Rs.	350.00
Per capita income in 1991	Rs.	450.00

36. The projection of demand of wood for the year 1981 and 1991 has been made by the following formula which has been used by F.A.O. in India.

$$\text{Log}\ \frac{Y^1}{Y} = 0.4343 \times I.E. \left(1 - \frac{X}{X^1} \right)$$

Where Y^1 = per capita consumption at Target date,

Y = = per capita consumption at starting point.

I.E. = Income Elasticity

X = per capita income at starting point.

X^1 = per capita income at target date.

The constant 0.4343 is derived by F.A.O. from cross-sectional data. As no historical series of consumption figures are available it is not possible to work out a separate income elasticity applicable to the area. It is therefore, proposed to adopt an income elasticity of 0.8 which is the factor arrived by F.A.O. for India.

37. FORECAST FOR WOOD CONSUMPTION.

Using the formula given in the above para the quantity of different species used for construction and repair of houses for agricultural implements, for fuel and for other domestic uses has been summarised in the following Table No. VII-18

Table No. VII-18

FORECAST OF WOOD CONSUMPTION

	Chir		Kail		Deodar		Fir/Spruce		B.L.		Total	
	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
1. House Construction & Repairs.	33344	65220	5304	10366	19331	38953	-	-	7938	15498	65917	130037
2. Agricultural Implements.	4929	9632	-	-	1644	3211	-	-	26297	51398	32870	64241
3. Fuel (Recorded)	1953	3814	142	281	142	281	494	975	27506	53767	30237	59118
4. Other Domestic uses.	6196	12112	-	-	-	-	-	-	6196	12112	12392	24224
Total	46422	90778	5446	10647	21117	42445	494	975	67937	132775	141416	277620

38. FORCAST FOR INDUSTRIAL WOOD

The wood required for furniture making, packing case industries have also been projected by the formula discussed in paragraph 36. Timber requirements for Hydel projects and other Departments would continue for many more years in future. Some more projects may be taken up during 6th & 7th Five Year Plans. Therefore, timber requirements for Hydel projects have been assumed to be the same annually. Timber requirement for other departments have also been projected.

Assuming that the species proportion in use would remain the same, the forecasts have been made and is given in Table No. VII - 19.

Table No. VII-19

FORECAST OF INDUSTRIAL WOOD FOR 1981 AND 1991

Use	Chir		Kail		Deodar		Fir/Spruce		B.L.		Total	
	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
1. Furniture Industry	137	257	137	257	630	1215	-	-	200	393	1104	2122
2. Packing Case Industry	51229	100135	-	-	-	-	12807	24971	-	-	64036	125106
3. Hydel Projects	-	-	-	-	8908	8908	-	-	7809	7809	16717	16717
4. Other Departments	893	1745	5	9	32	51	-	-	42	85	972	1890
Total	52259	102137	142	266	9570	10174	12807	24971	8051	8287	82829	145835

39. FORECAST FOR RAILWAYS & D.G.S. & D.

It is expected that use of wooden sleepers will continue inspite of available replacements. The quantity may, however, not increase substantially because of easily available replacements. Therefore, it has been presumed that the same quantity would be required as is being used at present.

40 The total wood requirement during 1972. 1981 and 1991 is summarised in the Table No. VII - 20.

Table No. VII-20

TABLE SPECIES WISE CONSUMPTION OF WOOD FOR THE YEAR 1972, 1981 AND 1991

Species	1972	1981	1991
Chir	75955	123833	218067
Kail	3015	5688	11013
Deodar	22363	32501	54433
Fir/Spruce	16698	23108	35753
Broad leaved	43310	75988	141062
TOTAL	161341	261118	460328

CHAPTER-VIII

WOOD BALANCES

1. DETERMINING WOOD BALANCES :

In order to have sustained supply of raw material for proposed wood based industries, it is necessary to assess the present level of wood consumption by local population and existing industries and to make realistic projections for the future. This quantity would be set apart from potential annual cut for meeting the requirement of local population and certain other committed demands. The balance quantity left would be used for planning a wood based industry.

2. WOOD BALANCES :

The present consumption and the estimated demand for timber for the year 1981 and 1991 is given in table No. VII - 20 which is reproduced below :

Table No. VIII-1.

PRESENT CONSUMPTION AND PROJECTED FUTURE DEMAND

Cubic Metres

Species	1972	1981	1991
Chir	75,955	1,23,833	2,18,067
Kail	3,015	5,688	11,013
Deodar	22,363	32,501	54,433
Fir/Spruce	16,698	23,108	35,753
Broad Leaved	43,310	75,988	1,41,062
Total	1,61,341	2,61,118	4,60,328

3. The wood balances after meeting the requirements of the local population and existing industries under the two cutting Models works out as below :

Table No. VIII-2

WOOD BALANCE (in 000 m^3)

Species	YEARS					
	1972		1981		1991	
	MODEL		MODEL		MODEL	
	I	II	I	II	I	II
Chir	216	327	168	279	74	185
Kail	19	27	16	24	11	19
Deodar	39	65	28	54	7	33
Fir/Spruce	b44	03	38	57	25	44
Oaks	440	477	407	444	342	379
Total	758	969	657	858	459	660

Note : Upland hardwoods and lowland hardwoods have been left out of calculation (Cf. Chapter V).

4. It is assumed that Deodar will be felled only to the extent for meeting the requirements of local population and surplus if any will be exported out side the area for uses other than paper and pulp. The total volume available for industrial purposes from Chir, Kail, Fir/Spruce and Oaks will be as follows :-

WOOD AVAILABLE FOR INDUSTRIAL PURPOSES

in ' 000 ' cubic metres

	YEARS					
	1972		1981		1991	
	Model		Model		Model	
	I	II	I	II	I	II
Coniferous Wood (Chir, Kail, Fir and Spruce)	279	417	222	360	110	248
Oaks	440	477	407	444	342	379
Total	719	894	629	804	452	627

5. Further, assuming that it may take 10 to 15 years to establish a pulp and paper mill it is proposed that the wood balances as available in the year 1991 should only be considered for industrial purpose.

6. Thus the wood available for industrial purpose from Chir, Kail, Fir/ Spruce and Oaks under the two cutting Models is given below :

Model	Wood available	000 m^3
I	Coniferous	110
	Oak	342
	Total	452
II	Coniferous	248
	Oak	376
	Total	627

7. Entire quantities of wood as given in para 6 may not be available for utilization on account of silvicultural requirements of the crop, inaccessible and difficult terrain, inefficient present logging techniques and several other factors.

Sufficient margin ofsafety has to be left as a buffer against any unforeseen calamities affecting the supply of raw material. It is, therefore, presumed that only 50% of these wood balances will be available for industrial purposes. The quantities available under two cutting Models would be as under :

Model	Industrial wood	Volume (in '000 : m^3)
I	Coniferous	55.0
	Oaks	171.0
	Total	226.0
II	Coniferous	124.0
	Oaks	189.5
	Total	313.5

CHAPTER - IX

ACCESSIBILITY AND COST STUDIES

1. DELIVERY SITE

Accessibility and cost studies were undertaken in the area. Two delivery sites were fixed with respect to which these studies were undertaken.. These sites are - Rishikesh and Dak Pathar.

2. OBJECTIVE

In order to determine the feasibility or otherwise of establishing a wood based industry it is of utmost importance to know the cost at which the raw materials are available at the delivery sites. Therefore, the object of these studies were :-

i) to work out the total cost of wood to be delivered at the proposed sites having taken into consideration all the factors influencing the cost.

ii) to work out the volume which is uneconomical to extract.

iii) to examine the possibility of any modification in the current logging/transport practices.

iv) to plan for a new road system in areas where the roads are inadequate or nonexistent and sufficient wood is available.

3. METHODOLOGY

i) The whole of survey area was devided into catchments on the drainag pattern of the area. Four catchments were recognised. These are, Bhilangana, Bhagirathi, Yamuna and Tons. Two delivery sites were fixed. These are Dak Pathar for Tons and Yamma catchments and Rishikesh for Bhagirathi and Bhilangana catchments.

ii) Each catchment was divided into suitable logging units or cost units from where all the calculations of infra-structure and other details were recorded.

iii) Each such unit which had contractor coupes in working were visited and the cost on account of various logging operations were derived by conducting case studies in 78 logging coupes representing the entire range of variation of topography and other working conditions in the area.

iv) With the help of questionnaires and proformas, specially trained crews interviewed the forest lessees and sub-contractors who were engaged in actual logging operations in the coupes in order to collect cost components of various logging operations.

v) In all 20% of the total cost units were visited, and details of terrain, infra-structure and other details were recorded. The details of other cost units were recorded from topographical map sheets.

vi) If number of alternatives for transport modes are available from a particular cost unit the cheapest one was considered.

vii) The cost of various operations was collected and converted into cost/cubic metre/Km. for transport. The entire object was to work out the cost which includes the cost of felling, conversion, loading, unloading and transport for each cost unit and attaching it to the volume available depending upon the volume of the sample points falling in the particular cost unit.

viii) The cost for each unit was thus worked out and grouped into different cost classes. Detailed procedure of the field work has been given in part II of the report.

4. FACTORS INFLUENCING LOGGING COSTS

Logging costs i.e. expenditure incurred in felling and extraction of forest raw materials from the stump to the delivery site-are influenced by large number of factors. These factors are described below :-

5. ALTITUDE

Logging costs are generally higher in higher altitudes, because conditions of working are difficult and period available for working is also short. Species such as fir and spruce occur mostly in higher altitudes while Chir in lower altitudes. Table No. IX-1 shows the area of different forest types in different altitudes :

Table No. IV -1

AREA OF FOREST TYPES AND ALTITUDES

Unit - Square Kms.

Altitudes	FOREST TYPES							
	Chir	Bluepine Deodar	Fir/ Spruce	Oaks	Lowland hard-woods	Up-land hard wood	Upland hard-wood	% to
Upto 1000 metres	4.24	-	-	-	67.88	[illegible]	72.12	[illegible]
1000 to 2000 metres	1035.07	42.42	8.49	152.71	29.69	80.60	1348.98	34.
2000 to 3000 metres	182.41	118.78	123.02	1302.32	-	250.28	1976.81	51.
3000 and above metres	-	50.90	84.84	237.56	-	101.81	475.11	12.
Total	1221.72	212.10	216.35	1692.591	97.59	432.69	3873.02	100

6. TOPOGRAPHY

Topography plays an important role in determining the method of extraction, pattern of conversion, machines to be used and ultimately, affecting the logging cost. Logging costs are generally higher in hilly areas than in plains. Most of the area is hilly. The area of different forest types under different terrain is given in Table No. IX-2.

Table No. IX - 2.

AREA OF DIFFERENT TYPES AND TERRAIN

Unit - Sq. Kms.

Terrain	FOREST TYPES						
	Chir	Blue Pine Deodar	Fir/ Spruce	Oaks	Lowland hard wood	Upland hard-wood	Total
Flat	-	-	-	-	8.49	-	8.49
Gentle rolling	436.94	59.40	16.97	190.89	21.21	80.59	806.00
Steep slopes	759.33	110.28	131.51	1221.72	63.63	254.53	2541.00
Precipitous	25.45	42.42	67.87	279.98	4.24	97.57	517.53
Total	1221.72	212.10	216.35	1692.59	97.57	432.69	3873.02

7. SLOPE

General slopes in cost units were also studied. The area of different forest types under different category of slopes is given in table No. IX-3.

Table No. IX - 3.

AREA OF DIFFERENT FOREST TYPES UNDER DIFFERENT SLOPES

Unit - Sq. Kms.

	FOREST TYPES						
	Chir	Blue-pine Deodar	Fir/ Spruce	Oak	Upland hard-wood	Lowland hard-wood	Total
70° and above	-	4.24	4.24	21.21	8.49	-	38.18
60° to 70°	21.21	4.24	16.97	50.91	4.24	-	97.57
45° to 60°	250.28	33.94	33.94	364.82	63.62	12.73	759.33
25° to 45°	882.35	156.95	135.75	1069.00	309.58	80.60	2654.33
Less than 25°	67.88	12.73	25.45	186.65	46.66	4.24	343.61
Total	1221.72	212.10	216.35	1692.59	432.69	97.57	3873.02

Harvesting of forest occurring on slopes higher than 60° is generally difficult.

8. CLIMATE

The climate governs the period during which extraction of wood is possible during the year. Each catchment has been studied in this respect and table No. IX-4 shows the percentage of total area and the number of months during which extraction is possible.

S.No.	Name of catchment	Percentage of area where extraction is possible			
		More than 9 months	6-9 months	3-6 months	Less than 3 months
1.	Bhilangana	22	40	38	-
2.	Bhagirathi	37	21	42	-
3.	Yamuna	36	63	1	1
4.	Tons	31	69	-	-

9. INFRA-STRUCTURE

Poor infra-structure in an area means high cost of extraction of forest resources from the area. Nearness to road, or rail head or launching depot is an important factor to be taken into consideration. Off-road transport costs may be so high that the exploitation of forest may become prohibitive.

10. NEARNESS TO ROAD

The road density for each catchment of the area has been worked out and is given below :

S.No.	Catchment	Road Density in Km./Sq. Kms.
1.	Bhilangana	0.05
2.	Bhagirathi	0.97
3.	Yamuna	1.70
4.	Tons	2.70

The name with length and type of road has been given in Appendix 1. The study of road distances in respect of each Logging unit has been studied. It has been found that roads are fewer in Bhilangana catchment in comparison to other catchments. Most of the forests are distantly located for away from the roads.

11. FOREST DENSITY

In a dense forest cost of extraction per cubic metre is generally less than in open forest. Table No. IX - 4 gives the area of different forest types under different crown densities.

Table No. IX - 4

FOREST AREA AND CROWN DENSITY

Area - Sq. Km.

Crown density	Chir	Blue-pine Deodar	Fir/ Spruce	Oak	Upland hard-wood	Lowland hard wood	Total
0 to 0.2	80.60	12.73	4.24	55.15	29.69	21.21	203.62
0.2 to 0.4	411.49	25.45	12.73	148.47	46.66	33.93	678.73
0.4 to 0.6	534.50	93.32	97.57	721.15	169.69	29.70	1645.93
0.6 to 0.8	190.89	63.63	84.84	568.44	127.26	12.73	1047.79
0.8 and more	4.24	16.97	16.97	199.38	59.39	-	296.95
Total	1221.72	212.10	216.35	1692.59	432.69	97.57	3873.02

12. AVAILABILITY OF LABOUR

The position of availability of labour has been studied for each unit and it has been found that generally logging labour is available in sufficient number. Most of these labourers are from outside and are brought by contractors. Some of the imported labour force is from Himachal Pradesh. Local labourers are not very much trained. Generally 25% of the labourers are brought from outside.

13. PRESENT LOGGING MANAGEMENT

Felling is done in the coupes according to working plan prescriptions. The coupes generally consist of a part of a compartment or sub-compartment or whole of compartment. The area of a coupe ranges from 50 hectares to 1500 hectares. The trees which are to be felled are marked and an estimate of volume and value is made. The marked coupes are usually sold in the auction to contractors. The lessee undertakes the entire logging operation from stump to the timber market. The lessee pays the royality to forest department and earns profit or suffers loss. The lease period generally varies from 1 to 5 years depending upon the quantum of work involved. Departmental extraction has also started and this activity will be enlarged.

14. PRESENT LOGGING PRACTICES

i) FELLING

Coniferous species are generally felled with axe and saw. Broad leaved species are generally felled by axe only. Use of power chain saw is completely absent.

ii) CROSS CUTTING

Debarking is generally done before the trees are cut into logs. Trees are cut into desirable log lengths (generally 3 metres). Crosscutting is generally done by two-man cross-cut saw. If the transport is to be done in the form of log debarking is not done. In case the log is converted into sleepers or scantlings debarking is done at the time of squaring. Squaring is done mostly by axe. Later on, ripsawing is done manually.

iii) TRANSPORT

Transport consists of two parts :
(a) Off-road transport
(b) Road transport

The off-road transport consists of one or combination of more than one of the following methods :-

(a) Skyline cranes and gravity ropeways
(b) Dry slide
(c) Wet slide
(d) Rolling
(e) Manual carriage
(f) Carriage on mule back

Skyline cranes and gravity rope-ways are used for a fraction of the produce. The device is not very popular because of high installation costs. Dry and wet slides are used for smaller distances generally inside the coupe. Construction of Dry or wet slide for longer distances is not only impractical but also uneconomical. Manual carriage is very common. Coniferous species are generally converted into sleepers and transported manually. Broad leaved species are generally transported on mule-backs.

The following table gives the percentage area (workable) under different types of road transport :

Table No. IX - 5

PERCENTAGE AREA UNDER DIFFERENT OFF ROAD TRANSPORT

S.No.	Name of catchment	Gravity ropeway	Manual Labour including rolling	Carriage on mules
1.	Bhilangana	1.0	85.0	14.0
2.	Bhagirathi	1.5	78.5	20.0
3.	Yamuna	2.5	65.0	32.5
4.	Tons	-	100.0	-

15. ROAD TRANSPORT

Road transport is done by 5 ton trucks. Broad leaved species are generally transported by trucks. Coniferous species from some areas are also brought by road. The following table shows the percentage of total area under working where transport by road or floating is adopted.

Table No. IX - 6

S.No.	Name of catchment	Road Transport	Floating
1.	Bhilangana	15.5	84.5
2.	Bhagirathi	61.2	38.8
3.	Yamuna	42.8	57.2
4.	Tons	100	-

Free floating is adopted in main rivers i.e. Yamuna, Bhagirathi and Bhilangana. Most of the coniferous species are transported by main rivers.

LOGGING COST

16. MARKING OF TREES FOR FELLING

The information was collected from 25 case study coupes for direct costs incurred on marking of trees in the coupes. The information of total costs and the number and sizes of trees was collected from Divisional Forest Office records. The cost per cubic metre has been worked out by assuming 60 cm. dbh. of marked trees.

The cost of marking per cubic metre for marking lower diameter classes comes to be high because contribution of lower diameter classes to the total volume is proportionately very little in comparison to the higher diameter classes. Since the proportion of different diameter classes in different coupes is generally different and hence the cost per cubic metre has been worked out by assuming average diameter of 60 cm. of the crop. The cost of marking (excluding demarcation of boundaries of coupes, and establishment charges) comes to Rs. 0.03 per cubic metre.

17. FELLING

Felling is mostly carried out by saw and axe. The payment is generally made on per tree basis depending upon the diameter of tree. Lopping and roping is included in the felling operation and the charges are also included in the felling cost. The lessees generally account for all felling and conversion charges in terms of B.G. representing Broad gauge sleeper (4.2 cft.). This facili- tates giving further sub-contract to petty contractors.

Felling rates are generally higher in higher altitudes. The felling rates in all the catchments vary from Rs. 4.00 to 6.00 per cubic metre. Felling charges for broad leaved species are higher than coniferous species.

The following are the average felling costs as collected from the case studies.

TABLE NO. IX-7.

FELLING COST PER CUBIC METRE.

Sl.No.	Name of Catchment	Coniferous species Rs./m^3	Broad leaved Rs./m^3
1.	Bhilangana	5.00	6.50
2.	Bhagirathi	4.50	6.50
3.	Yamuna	4.75	6.00
4.	Tons	5.00	6.25

18. LOG MAKING:

The process of conversion includes cross cutting of felled trees into logs, delimbing and debarking. Cross cutting is mostly done by cross-cut saws. Delimbing and debarking are done by axe. 3 metres long logs are generally made.

Case studies have revealed that the cost of log making is Rs. 4.65 per cubic metre.

19. SLEEPER MAKING:

Most of the coniferous wood from the area is removed in the form of sleepers. This conversion at the site decreases the cost of transportation and facilitates off road transports such as manual carriage, dry and wet slides, gravity ropeway and telescopic floating etc. The sleeper making is done by:

(a) Manual Sawing

(b) Machine Sawing

Manual Sawing is usually carried out at the site of felling itself. This is a wasteful method. The recovery is about 50%. The sleeper making is done on piece-meal basis. The cost of sleeper making is higher in higher altitudes and remote forests. The cost per cubic metre varies from Rs. 28.00 to Rs. 48.00. Average cost comes to Rs. 34.45 per cubic metre of sawn volume as revealed by case studies.

Machine sawing is not common. Logging Division Uttarkashi generally extracts logs and converts the logs into sleepers at Gangori. Portable sawing machines are not commonly used. The cost through machine sawing works out to Rs. 23.05 per cubic metre taking into consideration the capital cost and depreciation etc.

20. ENGRAVING PROPERTY MARK:

The operation consists of engraving property mark on two faces of the sleeper/logs before they are transported from the forest. In case of logs this operation also includes cleaning of the ends. The payment is made on piece meal basis. Generally, Rs. 2.00 per 100 marks is the rate in the area. The rate for

engraving property mark for different produce is as under:

i) Sleepers and scantling = Rs. 0.3/ cubic metre of sawn volume.

ii) Logs = Rs. 0.12 -do- -do-
(Assuming 0.5 cubic metres as the volume of the log.)

21. MINOR TRANSPORTATION:

Minor Transportation consists of one or more than one of the following methods:-

i) Rolling
ii) Manual carriage.
iii) Carriage on the mules
iv) Dry slide
v) Wet slide
vi) Telescopic floating
vii) Gravity ropeway.

22. ROLLING:

Most of the lessees in the area extract coniferous timber in the form of sleepers and therefore, rolling is generally not resorted to. Only 10-15% material is extracted in the form of logs from the survey area. The operation of rolling involves hard & risky work. Rolling of logs over a long distances is not only expensive but impracticable also. Cost of rolling varies with terrain, size of logs, and skill of labourers. The cost of rolling from the case studies works out to Rs. 9.35 cubic metre/Km.

23. MANUAL CARRIAGE:

The timber converted in the form of sleepers is often carried on human backs to the road side or launching depot. This method is resorted to for a distance upto 5 Km. The cost of transport varies according to altitude, distance from road side or launching depot and gradient.

The cost of transport by this method comes to Rs. 10.00 to Rs. 17/Km./m^3. The average cost calculated from 46 case studies works out to Rs. 12.20/cubic metre/Km. of sawn wood.

24. CARRIAGE ON THE MULE BACK:

This method is employed in case of broad leaved species, where the logs are made of smaller sizes. The carriage of timber by this method depends upon slope and the route. The average cost of transport worked out from 15 case studies, to Rs. 5.15/cubic metre/Km.

25. DRY SLIDE:

These are trough shaped structures constructed out of sawn material and fitted roughly together. The gradient requirements is 1:3.5 to 1:7. Dry slides are generally constructed over short distances. The timber is carried manually to the slide head.

The estimated cost/cubic metre/Km. comes to Rs. 5.23.

26. WET SLIDES:

Wet slides are just like dry slides except that in this case the water is also used as a motive power in addition to gravity. The sleepers which are used for construction of wet slides are also brought down when no longer required. The success of this method of extraction depends upon continuous and sufficient flow of water in the slides. The estimated cost of wet slides comes to Rs. 2.87/cubic metre/Km.

27. TELESCOPIC FLOATING:

This method of floating is adopted to bring down sleepers in a stream with bouldary beds at certain places or with other obstructions which create difficulties in free floating. Some arrangements are made at different places for the purpose of retaining water and providing pass-ways. Generally sawn material is used for construction of such passways. Floating in these nallahs is generally carried out during rainy season when there is sufficient water from rain and melted snow in the nallahs.

The cost of floating depends upon torrain of Nallah and number and length of obstructions. The length of telescopic floating in the area varies from 5 Kms. to 50 Kms. and the cost varies from 0.54/Km. to 1.00/Km. per cubic metre. The average cost comes to Rs. 0.86 per cubic metre per Km.

28. GRAVITY ROPEWAYS:

There are two or three load carrying ropes usually of 8 mm diameter called track-ropes. These are fixed between loading and unloading stations. There is a continuous endless rope of 6 mm diameter commonly known as control rope. The load is hung on track rope and is also attached with the control rope. The ideal slope is between 22°-35° and safe working load is 0.25 m°.

The cost consists of operational cost, depreciation on equipment, and installation cost. The average cost including the depreciation on equipment as calculated from 7 case studies comes to Rs. 3.60/cubic metres. The span of ropeways is generally within a Kilometre.

29. MAJOR TRANSPORTATION:

Transport by road is mainly by 5 ton trucks. The cost of transport was assessed by direct inquiry from the lessees. The lessees normally hire trucks for transporting their timber to the markets. Some of the lessees have their own fleet of trucks. The normal capacity of trucks is 7 cubic metres.

The cost as worked out from 36 case studies is given below:-

Road Class		Cost in Rs./cubic metre/Km.
(a) Hill Pucca	..	0.63
(b) Hill Kachha.	..	0.90

The cost includes loading and unloading charges also.

30. FREE FLOATING:

Free floating is carried out in Yamuna, Bhagirathi and Bhilangana rivers. Mostly sleepers are being floated. The cost of free floating includes the cost of launching, water fee, cost of collection sorting and stacking.

The timber floated in Yamuna river is collected at Dakpathar and timber floated in Bhagirathi and Bhilangana rivers is collected at Rishikesh. The approximate distances of these rivers where free floating is carried out is given below:-

Name of river.		Approximate distance in Km. where free floating is done.
1. Bhilangana	..	170
2. Bhagirathi.	..	250
3. Yamuna.	..	120

The period for floating is between October to March when there is no danger of any floods. The cost of free floating has been assessed from 46 case studies and the average cost works out to be Rs. 0.15/cubic metre/Km. in case of Bhagirathi and Bhilangana rivers and Rs. 0.21/cubic metre/Km. in case of Yamuna river.

31. AMENITIES TO LABOUR:

Some amount of expenditure is also incurred in providing certain amenities to the labourers employed in logging operations. The labour camps are set up by labourers and the wages for these days are paid by the lessee. The supply of ration, medicines etc; is also made on subsidised rates.

It has not been possible to work out the exact quantum of expenditure involved in providing these facilities to labourers. Nevertheless

it can not be ignored. It is proposed to provide 10% of all items of expenditure in respect of these amenities excepting for marking and major transport expenditure.

32. OVER HEAD CHARGES:

These include pay of Munshis and other staff employed by lessees or technical staff employed by State Forest Department. It is not possible to calculate the exact expenditure on over head charges for this study. Information for overhead charges has been collected from contractors. The over head charges varies from Rs. 5.00 to Rs. 15.00 per cubic metre. Average over head charges may be taken to be Rs. 10.00 per cubic metre.

33. SUMMARY OFCOST PER CUBIC METRE FOR VARIOUS OPERATIONS:

Item.		Average cost/m^3 in Rs.
1. Marking.		0.03
2. Rolling including roping & loping.	(a) Conifers	4.75
	(b) Broad leaved	6.25
3. Cross-cutting.		4.46
4. Sleeper making.	(a) Manual Sawing.	34.45
	(b) Machine Sawing.	23.05
5. Engraving property mark.	(a) Sleepers	0.30
	(b) Logs.	0.12
6. MINOR TRANSPORT.		
i) Rolling		9.35/km.
ii) Manual carriage.		12.26/km.
iii) Carriage on mule back		5.15/km.
iv) Dry slide.		5.23/km.
v) Wet slide		2.87/km.
vi) Telescopic floating.		0.86/km.
vii) Gravity ropeways.		3.60/km.
7. MAJOR TRANSPORTATION.		
i) Road transport including (loading and unloading)		
a) Hill Kachha.		0.90/km.
b) Hill Pucca.		0.63/km.
ii) a) Floating (Bhagirathi & Bhilangana)		0.15/km.
b) -do- (Yamuna)		0.21/km.
8. Amenities to labour		10% on all items from serial No. 2 to 12.
9. Over head charges.		10% on all items.

34. COST ANALYSIS:

In working out the different cost components of felling and extraction the prevelant methods of extraction in the area have been taken into consideration.

Cost of extraction has been worked out by making the following assumptions:-

(i) It has been assumed that coniferous species would be extracted as is the practice in the area. Coniferous species in most of the area are being extracted in form of sleepers.

(ii) Broad leaved species are being extracted in the form of logs only.

(iii) Transport of coniferous species has been assumed to be done by free floating where ever possible. In rest of the area transport by road has been assumed.

(iv) Transport of broad leaved species is done by road.

(v) Loss in floating has been included in calculating the cost of free floating.

(vi) The cost of extraction including felling and transport from the cost units to the delivery sites has been worked out for each cost unit. The cost of extraction varies from Rs. 60.00 per cubic metre to Rs. 250 per cubic metres. The costs of extraction are comparatively higher in Bhilangana Catchment than in other catchments.

35. COST CLASSES:

Twenty rupees cost classes have been formed. The total volume in a cost unit has been calculated on the basis of growing stock figures of the sample point falling in the cost unit. Attaching this volume to the cost of extraction of the unit, volumes in different cost classes have been worked out.

The volumes of different cost classes in different catchments for bringing to the delivery sites (Rishikesh for Bhilangana and Bhagirathi and Dakpathar by Yamuna and Tons) is given in Table IX-8 and IX-9.

TABLE NO. IX-8.

VOLUME IN DIFFERENT COST CLASSES.

Delivery site- Rishikesh

Volume in '000' cubic metres.

Cost classes	Volume of coniferous wood extracted as sleeper.	% of total volume.	Volume of Broad leaved species extracted as log.	% of total volume.
40-60	-	-	-	-
60-80	-	-	107	0.4
80-100	1842	8.9	517	2.1
100-120	7137	34.7	704	2.9
120-140	3412	16.6	5210	21.4
140-160	2434	11.8	9170	37.6
160-180	1613	7.8	5551	22.8
180-200	812	3.9	1399	5.7
200-220	2756	13.4	1355	5.6
	597	2.9	374	1.5
TOTAL:	20603	100	24387	100

Volumes in different cost classes in Yamuna and Tons catchment for the delivery site Dak-Pathar have been calculated and given below:-

TABLE NO. IX-9

VOLUME IN DIFFERENT COST CLASSES.

Delivery site- Dak-Pathar

Volume in '000' cubic metres.

Cost classes	Volume of coniferous wood extracted as sleeper	% of total volume	Volume of Broad leaved species extracted as log.	% of total volume.
40-60	-	-	297	2.4
60-80	-	-	374	3.1
80-100	-	-	743	6.1
100-120	820	7.3	1811	14.8
120-140	1970	17.4	3061	25.1
140-160	3458	30.6	3533	29.0
160-180	2362	20.9	800	6.6
180-200	780	6.9	1017	8.3
200-220	321	2.8	77	0.6
220 and above	1592	14.1	484	4.0
Total:	11303	100	12197	100

Thus, it is clear that maximum volume is in Rs. 100/- to Rs. 160/- cost classes. The volume in cost classes less than 100 is hardly 5.5%. The volume in cost class less than Rs. 100, Rs. 100 to 160 and more than Rs. 160/- is given below, 3.6% of the total volume is uneconomical to extract.

TABLE NO. IX-10.

Cost class in Rs.	Volume in '000' cubic metres	Percentage of total volume
Less than 100	3880	5.5
100-160	42720	60.1
Rs. 160 and above	21890	30.8
Uneconomical to extract	2589	3.6
	71079	100

36. PLANNING NEW ROADS:

Road and rivers are the two important modes of timber transport in the area. A much denser net work of road and extraction routes would be required in the area if the plans for intensive management and establishment of wood based industries is to make any head way. A net work of roads would have to be developed over the entire area in order to tap all the resources.

Road density in the different catchments of the area is as under:-

Sl.No.	Catchment	Road density in Km/Sq. Km.
1.	Bhilangana	0.05
2.	Bhagirathi	0.97
3.	Yamuna	1.70
4.	Tons	2.70

It is clear that Bhilangana Catchment is having very poor road net work. It is, therefore, proposed to construct the following roads in the area in order to tap the resources of the catchment.

Sl.No.	Name of the proposed road		Approximate distance in Km.
1.	Ghansali to Gangi	..	60 Km.
2.	Ghansali to Jhala chandani	..	40 Km.
			100 Km.

The distances have been calculated with the help of topographical map sheets.

37. COST OF ROAD CONSTRUCTION:

Assuming the cost of construction at Rs. 1,25,000 per kilometer, the total cost of construction works out to Rs. 12.5 million.

38. ECONOMIC CONSIDERATIONS:

This huge amount estimated to develop the road net work in the area is not necessarily to be spent immediately. Construction of roads can be phased out and can be regulated as per requirements of Logging plan.

Besides, forestry being the main benificiary there is going to be an over all development of the area particularly of Bhilangana catchment because of the proposed roads. It will link as number of inhabited areas and will generate employment potential in a big way. As a result of this investment variety of social benefits will accrue, justifying a part of investment to be accounted for social costs.

Even if this investment on the development of road net work is supposed to contribute nothing towards social cost and atributed solely to the cause of extraction of forest produce, it will cost on an average at the rate of Rs. 2.27/per cubic metre is by no means a heavy investment. This investment should be viewod in the light of the tremendous benefits, it will bring and the contribution it would make to the prosperity of the area.

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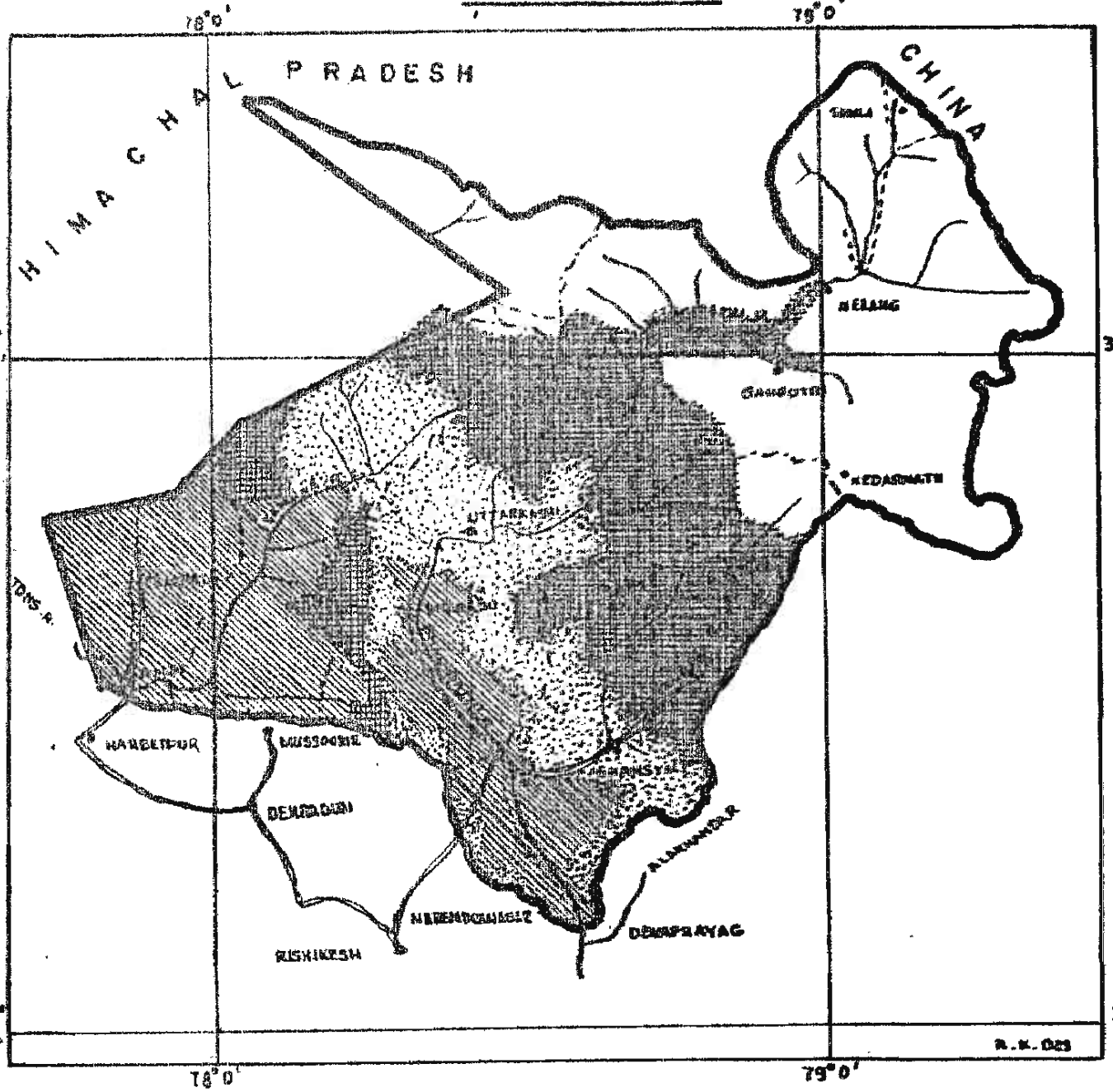
NATIONAL FOREST RESOURCES SURVEY.

COST CLASSES MAP FOR TIMBER – LOG.

(BHAGIRATHI, BHILLANGANA AND YAMUNA CATCHMENTS)

UTTARPRADESH

Scale : 1" = 16 Miles



REFERENCES		
	COST CLASSES M3 – IN Rs.	DEPICTION
Surveyed area		
Catchment Boundary	1. More than Rs. 160.	
Road metalled	2. Rs. 100 — 160	
" unmetalled		
" Proposed	3. Less than Rs. 100	
River		

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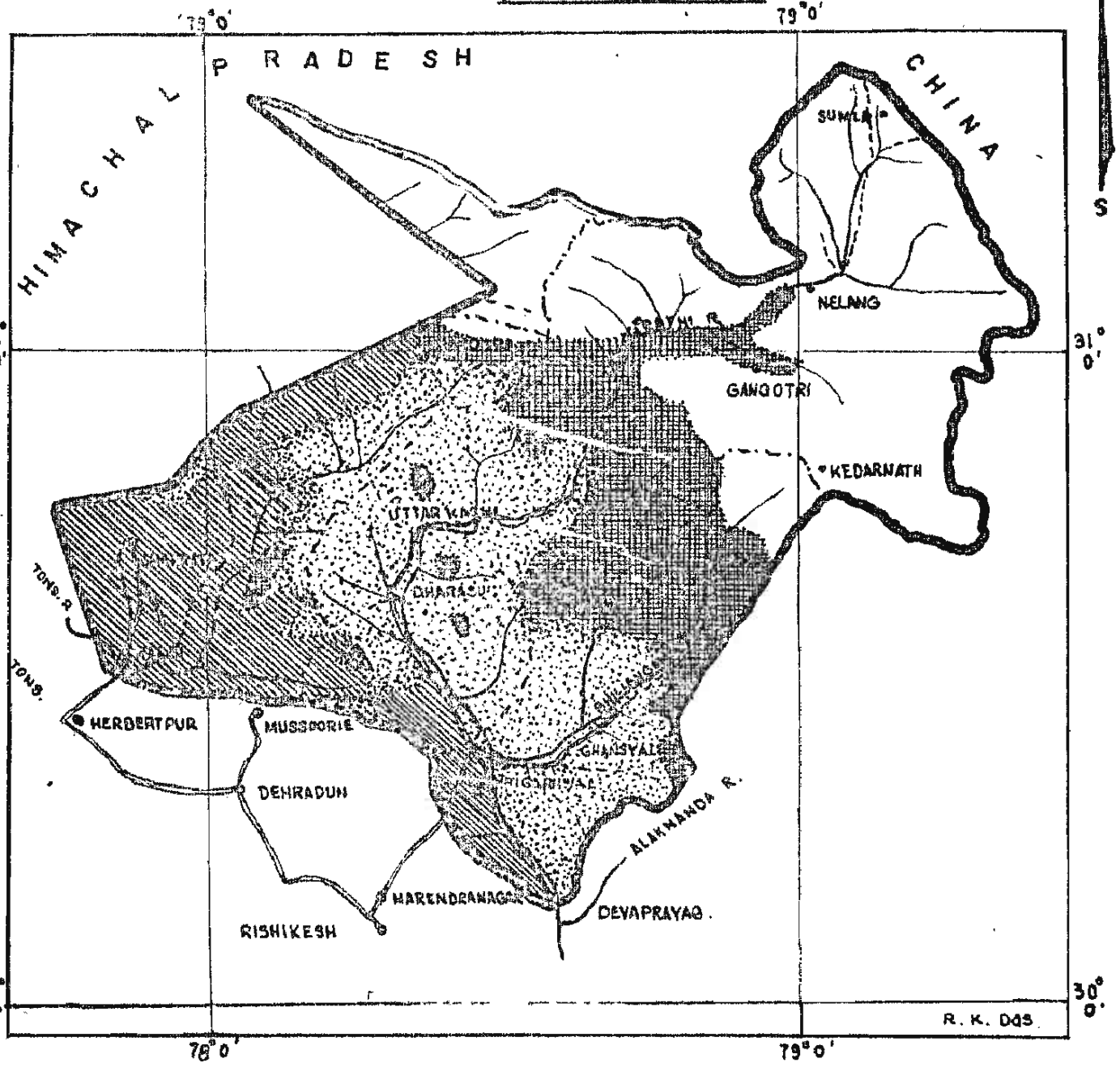
NATIONAL FOREST RESOURCES SURVEY

COST CLASSES MAP FOR PULPWOOD AND FUEL WOOD.

(BHAGIRATHI, BHILLANGANA AND YAMUNA CATCHMENTS)

UTTAR PRADESH

Scale : 1" = 16 Miles .



REFERENCES		
Surveyed area	COST CLASSES M3 IN Rs.	DEPICTION
Catchment Boundary	1. More than Rs. 160	
Road metalled	2. Rs. 100 — 160	
" unmetalled	3. Less than Rs. 100	
" proposed		
River		

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CHAPTER- X.

INDUSTRIAL POSSIBILITIES.

1. Survey has revealed that the area is rich in forest resources. These resources if tapped systematically and intensively could yield rich devidends to the forestry sector and may provide an effective lever for improving the standard of living of local populace.

2. The wood raw material available for industrial purposes as worked out already (Chapter-VIII) comes to:

Industrial wood	Volume ('000' m^3) Model-I	Model-II
Coniferous	55.00	124.0
Oaks	171.00	189.5
TOTAL:	226.00	313.5

3. Coniferous species such as Chir, Kail, Fir and spruce have long fibres and yield very good pulp. Oaks which form about 50% of the total growing stock are primarily used for fuel at present. Due to technological development in the field of pulping, it is possible to use hardwoods for pulp. Infact most of the existing pulp and paper mills in the country are using increasing quantities of hardwoods as raw material and new units are being planned on the basis of more and more use of hardwoods. It is, therefore, proposed to use Oaks for pulping which form the bulk of the resources.

4. Considering that 1.5 cubic metres wood is equal to one tonne in weight, the available wood in tonnes per annum for industrial purpose would be:

Industrial wood	Weight in Tonnes Model-I	Model-II
Coniferous	37000	83,000
Oaks	114000	1,26,000
TOTAL:	151000	2,09,000

Assuming 300 working days in a year, the capacity of industries that can be set up for different kinds of pulps are given in the Table below:-

TABLE NO. X-I.

Sl.No.	Kind of Wood	Kind of pulp	Yield	Capacity in tonnes/day Model-I	Model-II
1.	Coniferous wood	Ground wood	90%	111	249
		Semi chemical pulp	70%	86	194
		Chemical pulp	50%	62	138
2.	Oaks	Ground wood.	90%	342	378

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5. Thus it is clear that the area can feed different kinds of pulp mill/mills of the capacities as indicated in table No. X-1.

6. However, it may be cautioned that the industrial infrastructure in this region has not adequately developed for establishing a capital intensive industry like pulp and paper mill. A large number of skilled labour would be required to man the factory as well as to carry out the logging operations in the hilly terrain. However, it is hoped that by the time the pulp and paper mill comes to steam the required infrastructure would be developed, in view of the concentrated efforts that are being taken for the development of industries in the Hill Districts of Uttar Pradesh.

If a smaller unit of pulp and paper mill is planned the area may supply raw material to a plywood mill also.

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CHAPTER-XI.

R E C O M M E N D A T I O N S.

AVAILABILITY OF INDUSTRIAL RAW-MATERIALS:

i) Industrial raw-material for Pulp and Paper Mills of the capacities as calculated in table X-1 are available, under the two different cutting Models considered.

ii) Other aspects for the installations of Pulp and Paper Mills such as selection of site availability of power, transportation of chemicals and other important factors has, of course, to be got investigated.

2. REMOVAL OF CULL:

i) Percentage of cull in Fir/Spruce and Oaks is significant in large sized trees. It is, therefore, necessary that dead, diseased and over mature trees of these species should be removed on priority basis so as to stop the negative increment in these forests.

3. LOGGING:

i) In order to extract maximum quantities of wood at the cheapest cost as far as possible, there can be balanced blending of mechanised means and conventional methods of logging.

ii) Portable Saw Mills may be used for conversion in the coupes.

iii) Existing roads may be improved and the construction of new roads as suggested may be taken up as early as possible as per suggestion made in Chapter IX.

4. REGENERATION:

i) Artificial means of regeneration have to be adopted to augment natural regeneration of different species.

ii) Closures to grazing would be necessary for successful plantation programmes.

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5. MANAGEMENT PRACTICES:

i) Deodar may continue to be managed with the objective of the production of large size timber.

ii) On the finalisation of the Pulp mill forests of Chir, Kail, Fir/Spruces and Oaks shall have to be managed on concentrated regeneration systems to produce 40 cm. diameter trees for pulp wood and for timber required for fruit packing cases.

iii) The Silvicultural system to be used will depend on the requirement of the species and site depending upon various other factors.

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APPENDIX - I.

STATEMENT SHOWING CATCHMENTWISE EXISTING ROADS WITH DISTANCES AND ROAD DENSITY IN U.P. SURVEY AREA.

Catchment	Sl.No.	Name of the Road with nature.	Length in Kms.
BHILLANGA	1.	Tehri-chira batia khal P.W.D. pucca Road	52
	2.	Dobata-Paukhal P.W.D. pucca Road.	10
	3.	Tehri-Hindola khal P.W.D. Kacha Road (part)	10
	4.	Pateb-Akhari-sain Forest-Kacha Road	4
		Total:	76 Kms.
BHAGIRATHI.	1.	Deoparyag-Tehri Zila Parishad Kacha Road(Part)	5
	2.	Hindola khal-Tehri P.W.D. Kacha Road(Part)	38
	3.	Chamba-Dobara via Gaja Forest Kacha Road.	25
	4.	Chamba-Suringh Dhar Forest Kacha Road.	5
	5.	Bhaldiana Uttarkashi P.W.D. Pucca/Kacha Road.	72
	6.	Chamba-Gangotri via Uttarkashi P.W.D. Pucca Road(Part)	195
	7.	Lambgaon-Par ap Nagar P.W.D.- Kacha Road	22
	8.	Dhauntri-Sain P.W.D- Kacha Road	14
	9.	Dharasu-Chapra P.W.D. Pucca Road	40
	10.	Silkiasi-Bangaon Forest Kacha Road	18
	11.	Kari-Gair Forest Kacha Road	20
	12.	Nagunged-Mahidanda Forest Kacha Road	50
	13.	Thang. Dhar-Moldhar Forest Kacha Road	24
	14.	Gangori-Kardia P.W.D. Kacha Road	15
	15.	San-Kurna D-har Dewda Forest Road	20
	16.	Gangotri-Mahidanda Forest Kacha Road	7
		Total:	570 Kms.
YAMUNA.	1.	Mussoorie-Yamuna bridge P.W.D. Pucca Road	31
	2.	Mussoorie-Forest Road along main ridge	15
	3.	Kalsi Yamnotri P.W.D. Pucca/Kacha Road	150
	4.	Kalsi Chakrata P.W.D. Pucca Road	42
	5.	Chakrata-Tuni P.W.D. mettaled Road (Part)	10
	6.	Chakrata-Kharamba peak Forest Kacha Road	24
	7.	Chakrata-Deoban Forest Kacha Road(Part)	8
	8.	Newgaon-Purola P.W.D. Pucca Road	18
	9.	Chakrata-Yamuna bridge P.W.D. Kacha Road	32
	10.	Barkot-Saharasn P.W.D. Pucca Road(Part)	16
	11.	Purola-Kuthnor Forest Kacha Road via sainanl	52
	12.	Purola-Jurmola P.W.D. Kacha	20
	13.	Dhanaulti-Nagtisa Forest-Kacha Road	30
	14.	Chamba-Mussoorie P.W.D. Pucca Road	55
			503 Kms.
TONS.	1.	From Tuni Road Budher Forest Kacha Road	19
	2.	Richhari-Jalalia P.W.D. Kacha Road	18
	3.	Chakrata-Tuni P.W.D. mettaled Road(Part)	20
		Total:	57

APPENDIX NO. 2.1.

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES IN ENTIRE AREA

AREA IN Sq. Km. 3873.03

Species	DIAMETER CLASSES (Cm) -10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110 +	Total
Chir	14.34	32.57	23.95	14.93	7.10	3.27	.88	.24	.06	.02	.01	0.00	97.37
Kail	.69	3.94	1.32	1.26	.59	.18	.05	.02	.02	0.00	0.00	0.00	8.07
Deodar	.34	3.86	3.52	2.61	1.32	.68	.37	.15	.04	.04	.02	.01	12.96
Fir & Spruce	2.09	6.07	5.06	3.38	1.99	1.16	.72	.30	.23	.11	.06	.03	21.20
Oaks	45.41	94.51	37.76	16.38	9.29	5.59	3.17	2.01	.87	.51	.25	.15	215.90
Others	67.60	105.95	34.93	11.27	4.48	1.58	.85	.36	.18	.14	.04	.03	227.41
Total	130.47	246.90	106.54	49.83	24.77	12.46	6.04	3.08	1.40	.82	.38	.22	582.91

APPENDIX NO. 2.1.1

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE CHIR.

AREA IN Sq. Km. 1221.72

Species	DIAMETER CLASSES (Cm.)												
	-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	TOTAL
Chir	42.98	99.55	73.71	45.13	21.08	0.89	2.62	.66	.17	.05	.04	0.00	295.87
Deodar	0.00	0.00	.52	0.00	.05	.04	0.00	0.00	0.00	0.00	0.00	0.00	.61
Oaks	2.46	9.85	3.21	1.11	.69	.28	.37	.18	.05	.03	0.00	0.00	18.24
Others	9.99	10.13	2.58	.85	.29	.13	.02	.03	.02	0.00	0.00	0.00	24.04
Total	55.43	119.53	80.02	47.09	22.11	10.34	3.01	.87	.24	.08	.04	0.00	338.76

APPENDIX NO. 2.1.2

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE BLUE PINE AND DEODAR

AREA IN Sq. Km. 212.10

Species group	DIAMETER CLASSES (Cm) -10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	TOTAL
Olir	0.00	2.82	0.00	0.00	.52	.57	0.00	0.00	0.00	0.00	0.00	0.00	3.91
Kail	6.28	54.68	18.54	16.11	7.54	2.45	.50	[illegible]	.21	0.00	0.00	0.00	106.59
Deodar	6.29	66.11	56.50	43.93	21.39	11.50	5.96	2.45	.67	.58	.24	.24	215.86
Fir & Spruce	0.00	2.60	4.35	0.00	.49	.20	.12	0.00	0.00	0.00	0.00	0.00	7.76
Oaks	0.00	38.95	17.58	5.21	1.61	1.62	.75	.60	.14	.06	.05	.04	66.61
Others	6.29	34.56	7.10	3.58	.97	1.16	.66	0.00	.21	.11	.05	0.00	54.69
Total	18.86	199.72	104.07	68.83	32.52	17.50	7.99	3.33	1.23	.75	.34	.28	455.42

APPENDIX 2.1.3

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES IN FOREST TYPE-FIR AND SPRUCE

AREA IN Sq. Km :- 216.35

Species	DIAMETER CLASSES (Cm)												
	-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110 +	Total
Kail	0.00	4.84	2.46	.39	.68	0.00	.23	0.00	.08	0.00	0.00	0.00	8.68
Deodar	0.00	0.00	.68	0.00	.22	.38	.33	.17	.07	.11	.05	.23	2.04
Fir & Spruce	0.00	64.37	51.46	37.83	23.70	12.93	7.54	3.01	2.65	1.28	.72	.29	205.78
Oaks	26.14	19.68	13.25	5.29	6.21	2.59	2.69	1.36	.76	.32	.14	.23	78.66
Others	6.16	34.25	15.31	8.71	2.17	1.23	.91	.71	.35	.00	.10	.07	70.97
TOTAL	32.30	123.14	84.16	52.22	32.98	17.13	11.70	5.25	3.91	1.71	1.01	.62	366.13

APPENDIX NO. 2.1.4

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE OAKS

AREA IN Sq. Km. 1692.59

Species.	DIAMETER CLASSES (Cm.)												
	-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Chir	1.78	1.11	.32	.60	.40	.11	.03	.05	0.00	0.00	0.00	0.00	4.40
Kail	.79	1.37	.38	.33	.03	.07	.03	.01	.01	0.00	0.00	0.00	3.02
Deodar	0.00	.38	.29	.42	.13	.04	.03	.01	0.00	0.00	0.00	0.00	1.30
Fir & Spruce	3.78	3.61	3.08	2.07	.89	.66	.45	.15	.10	.03	.03	.01	14.86
Oaks	97.22	196.48	76.51	33.04	18.52	11.20	5.96	3.75	1.64	.94	.48	.26	445.80
Others	94.72	146.82	43.58	13.31	5.32	1.84	1.06	.45	.15	.13	.02	.02	307.42
Total	198.29	349.77	123.86	49.77	25.29	13.92	7.56	4.42	1.90	1.10	.53	.29	776.80

APPENDIX NO. 2.1.5

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE UPLAND HARDWOODS AND MIXED CONIFERS

AREA IN Sq. Km. 432.69

Species.	DIAMETER CLASSES (Cm) -10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Chir	0.00	4.78	5.06	3.87	2.25	.67	.33	.10	.04	0.00	0.00	0.00	17.10
Kail	0.00	.69	0.00	1.85	1.12	.18	0.00	0.00	0.00	0.00	0.00	0.00	3.84
Deodar	0.00	.69	.88	.21	.54	0.00	0.12	0.00	0.00	0.00	0.00	0.00	2.44
Fir & Spruce	3.90	6.76	5.39	3.32	2.22	1.19	.86	.56	.31	.17	.07	.10	24.85
Oaks	6.16	20.66	15.19	9.02	4.83	3.36	2.32	1.81	.81	.60	.30	.18	65.24
Others	162.20	275.61	105.16	36.54	15.33	5.20	2.29	1.09	.68	.64	.18	.13	605.05
Total	172.26	309.19	131.68	54.81	26.29	10.60	5.92	3.56	1.84	1.41	.85	.41	718.52

APPENDIX NO. 2.16

NUMBER OF STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE LOW LAND HARDWOODS.

AREA IN S_q. Km- 97.57

Species	DIAMETER CLASSES (Cm.) -10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Others	168.29	158.51	80.16	16.61	7.57	.84	1.36	0.00	0.00	0.00	0.00	0.00	433.43
Total	168.29	158.51	80.16	16.61	7.57	.84	1.36	0.00	0.00	0.00	0.00	0.00	433.43

APPENDIX- 2.2.

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR ENTIRE ARE(AREA IN Sq. Km. 3873.02)

Species	DIAMETER CLASSE (Cm.)											TOTAL.
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90,	90-100	100-110	110 +	
Chir	2.46	6.45	10.12	9.41	7.25	2.96	1.15	.36	.13	.13	0.00	40.42
Kail	.50	.52	.98	.86	.44	.20	.10	.13	0.00	0.00	0.00	3 .73
Deodar	.52	1.76	2.47	2.10	1.60	1.26	.66	.23	.27	.14	.19	11 .20
Fir & Spruce	1.07	1.85	2.63	2.74	2.55	2.41	1.40	1.44	.88	.87	.63	18 .27
Oaks	9.82	8.72	9.09	9.85	10.02	8.57	7.67	4.54	3.50	2.14	2.00	75. 92
Others	8.26	6.72	5.34	4.53	2.74	2.27	1.41	.93	.93	.34	.46	33. 93
TOTAL:	22.63	26.02	30.63	29.49	24.60	17.67	12.39	7.63	5.71	3.42	3.28	183.47

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APPENDIX NO. 2.2.1

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE CHIR

AREA IN Sq. Km. 1221.72

Species	DIAMETER CLASSES (Cm) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Chir	7.53	19.91	30.59	27.95	21.89	8.87	3.18	1.05	.42	0.43	0.00	121.82
Deodar	0	.29	0.00	.07	.07	0.00	0.00	0.00	0.00	0.00	0.00	.43
Oaks	1.20	.65	.58	.76	.51	.89	.60	.22	.17	0.00	.06	5.64
Others	.79	.44	.35	.27	.27	.06	.13	.15	0.00	0.00	0.00	2.44
Total	9.52	21.29	31.52	29.05	22.74	9.82	3.91	1.40	.59	.43	.06	130.33

APPENDIX NO. 2.2.2

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE BLUE PINE AND DEODAR

AREA IN Sq. Km. 212.10

Species	DIAMETER CLASSES (Cm.) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Chir	.21	0.00	0.00	.70	1.15	0.00	0.00	0.00	0.00	0.00	0.00	2.06
Kail	6.98	7.22	12.25	10.97	5.92	1.79	1.40	1.45	0.00	0.00	0.00	47.98
Deodar	8.99	28.34	41.74	34.25	27.16	20.06	10.87	3.76	4.18	2.09	2.93	184.37
& Fir/Spruce	.46	1.52	0.00	.79	.43	.52	0.00	0.00	0.00	0.00	0.00	3.72
Oaks	4.04	4.13	3.47	1.98	3.53	2.23	2.64	.75	.33	.33	.45	23.89
Others	2.70	1.18	2.00	1.08	2.15	1.63	0.00	1.14	.79	.41	0.00	13.07
Total	23.38	42.39	59.46	49.77	40.34	26.23	14.91	7.10	5.30	2.83	3.38	275.09

APPENDIX NO. 2.2.3

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE FIR AND SPRUCE

AREA IN Sq. Km. 216.35

Species	DIAMETER CLASSES (Cm.) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Kail	.62	.91	.35	1.19	0.00	.88	0.00	.47	0.00	0.00	0.00	4.42
Deodar	0	.41	0.00	.41	.82	1.23	.82	.41	.82	.41	.41	5.74
Fir & Spruce	11.31	18.39	29.87	32.83	28.63	25.12	14.56	17.22	10.60	8.21	5.86	202.60
Oaks	2.04	2.92	2.94	7.14	4.67	7.81	5.50	4.25	2.51	1.20	3.51	44.49
Others	2.67	3.16	4.16	2.01	2.05	2.65	2.83	1.86	0.00	.80	1.32	23.51
Total	16.64	25.79	37.32	43.58	36.17	37.69	23.71	24.21	13.93	10.62	11.10	280.76

APPENDIX NO. 2.2.4

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE OAKS.

AREA IN Sq. Km. 1692.59

Species	DIAMETER CLASSES (Cm.) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	Total
Chir	.06	.09	.41	.53	.25	.11	.22	0.00	0.00	0.00	0.00	1.69
Kail	.17	.16	.27	.05	.16	.10	.06	.06	0.00	0.00	0.00	1.03
Deodar	.05	.10	.37	.22	.10	.10	.05	0.00	0.00	0.00	0.00	0.99
Fir & Spruce	.63	1.22	1.59	1.21	1.44	1.46	.68	.58	.29	.32	.17	9.59
Oaks	20.40	17.66	18.13	19.46	20.07	16.09	14.32	8.55	6.51	4.00	3.43	148.62
Others	11.45	8.41	6.25	5.32	3.17	2.84	1.69	.75	.89	.15	.27	41.19
Total	32.78	27.64	27.02	26.79	25.19	20.70	17.02	9.94	7.69	4.47	3.87	203.11

APPENDIX NO. 2.2.5

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES FOR FOREST TYPE UPLAND HARDWOODS AND MIXED CONIFERS

Area in Sq. Km. 432.69

Species	DIAMETER CLASSES (Cm.)											TOTAL.
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110+	
Chir	.36	1.21	2.62	2.89	1.55	1.01	.43	.23	0.00	0.00	0.00	10.30
Kail	.09	0.00	1.58	1.52	.41	0.00	0.00	0.00	0.00	0.00	0.00	3.60
Deodar	.03	.41	.20	.82	0.00	.41	0.00	0.00	0.00	0.00	0.00	1.93
Fir & Spruce	1.19	1.82	2.41	3.03	2.67	3.02	2.59	2.00	1.44	.65	2.05	22.87
Oaks	2.15	3.66	5.59	5.30	5.70	6.26	6.94	4.10	3.97	2.70	2.34	48.71
Others	21.50	20.15	17.65	15.80	9.02	6.22	4.21	3.52	4.46	1.61	2.42	106.56
TOTAL:	25.38	27.25	30.05	29.36	19.35	16.92	14.17	9.85	9.87	4.96	6.81	193.97

@*@*@*@*@

APPENDIX NO. 2.2.6

VOLUME PER HECTARE BYSPECIES AND DIAMETER CLASSES FOR FOREST TYPE
LOW LAND HARDWOODS

AREA IN Sq. Km.97.57

Species	DIAMETER CLASSES (Cm)											
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110 +	Total
Others	12.36	16.19	7.16	7.34	1.27	3.61	0.00	0.00	0.00	.90	0.00	36.47
Total	12.36	16.19	7.16	7.34	1.27	3.61	0.00	0.00	0.00	.90	0.00	36.47

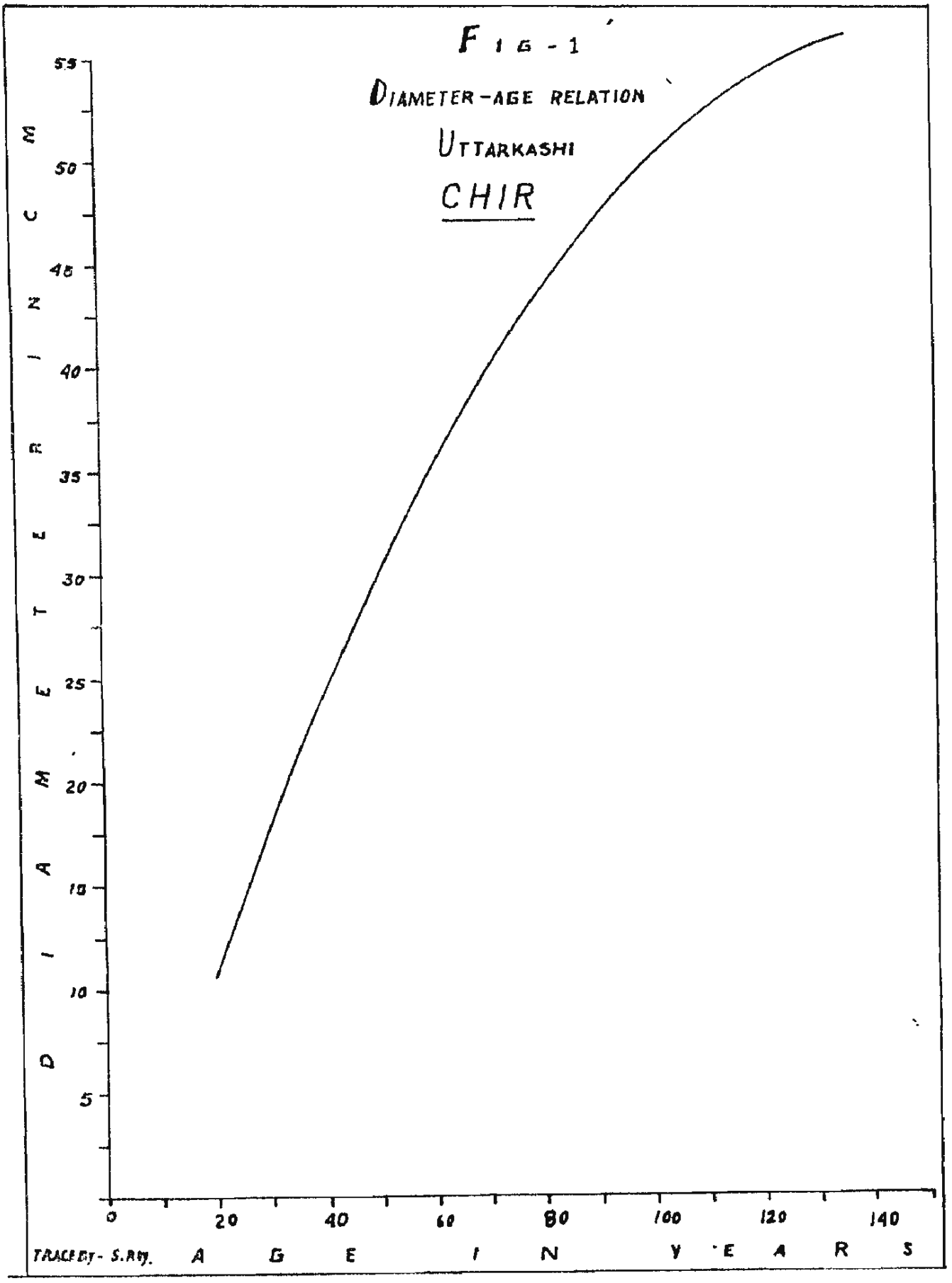


FIG - 1
DIAMETER-AGE RELATION
UTTARKASHI
CHIR
DIAMETER IN CM
55
50
45
40
35
30
25
20
15
10
5
0
20
40
60
80
100
120
140
AGE IN YEARS
TRACED BY - S.Roy.

Contents

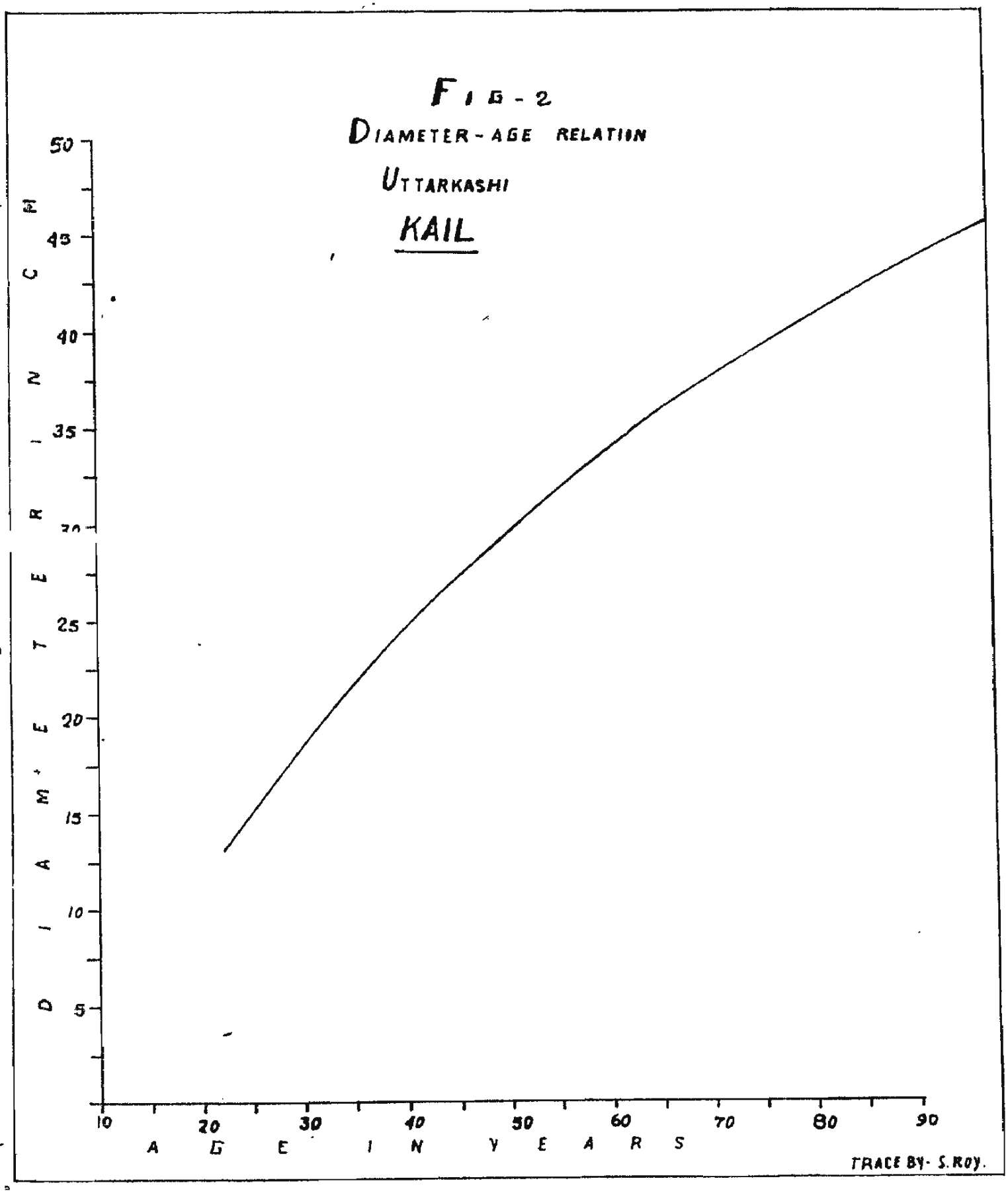


FIG - 2
DIAMETER - AGE RELATION
UTTARKASHI
KAIL
DIAMETER IN CM
50
45
40
35
30
25
20
15
10
5
10
20
30
40
50
60
70
80
90
AGE IN YEARS
TRACE BY- S.ROY.

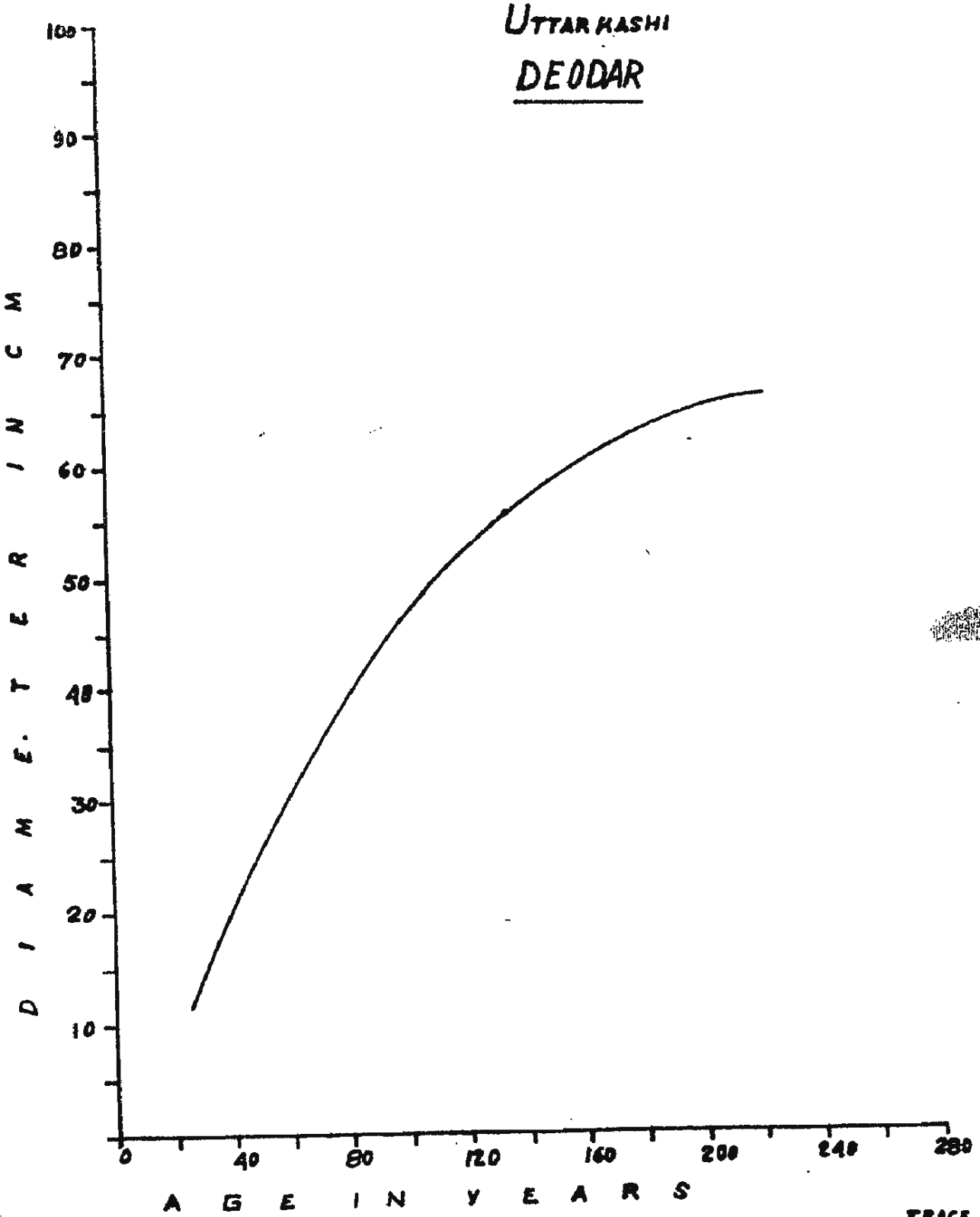
Contents

FIG - 3

DIAMETER-AGE RELATION

UTTARKASHI

DEODAR



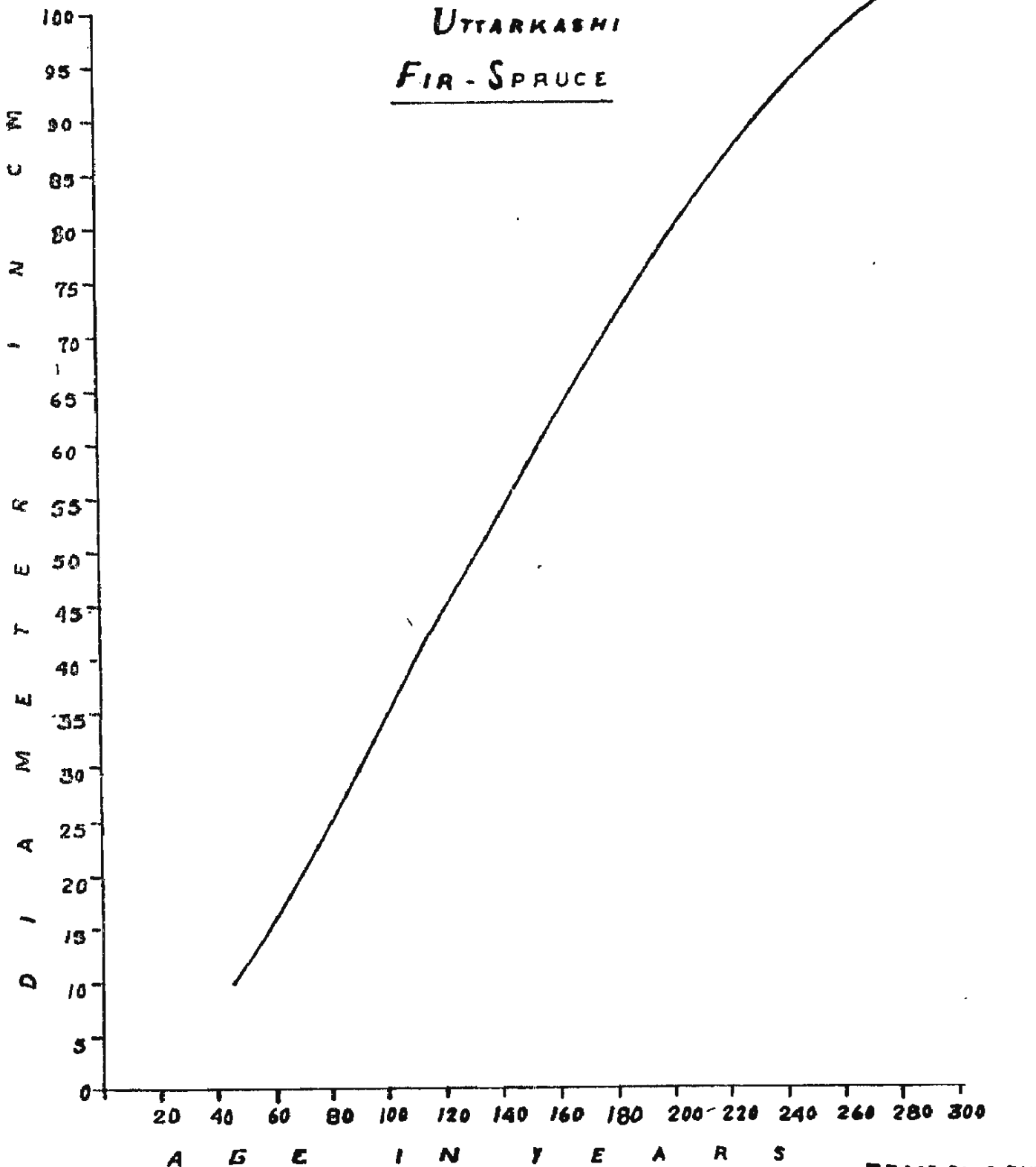
TRACE BY- S.ROY.

FIG-4

DIAMETER - AGE RELATION

UTTARKASHI

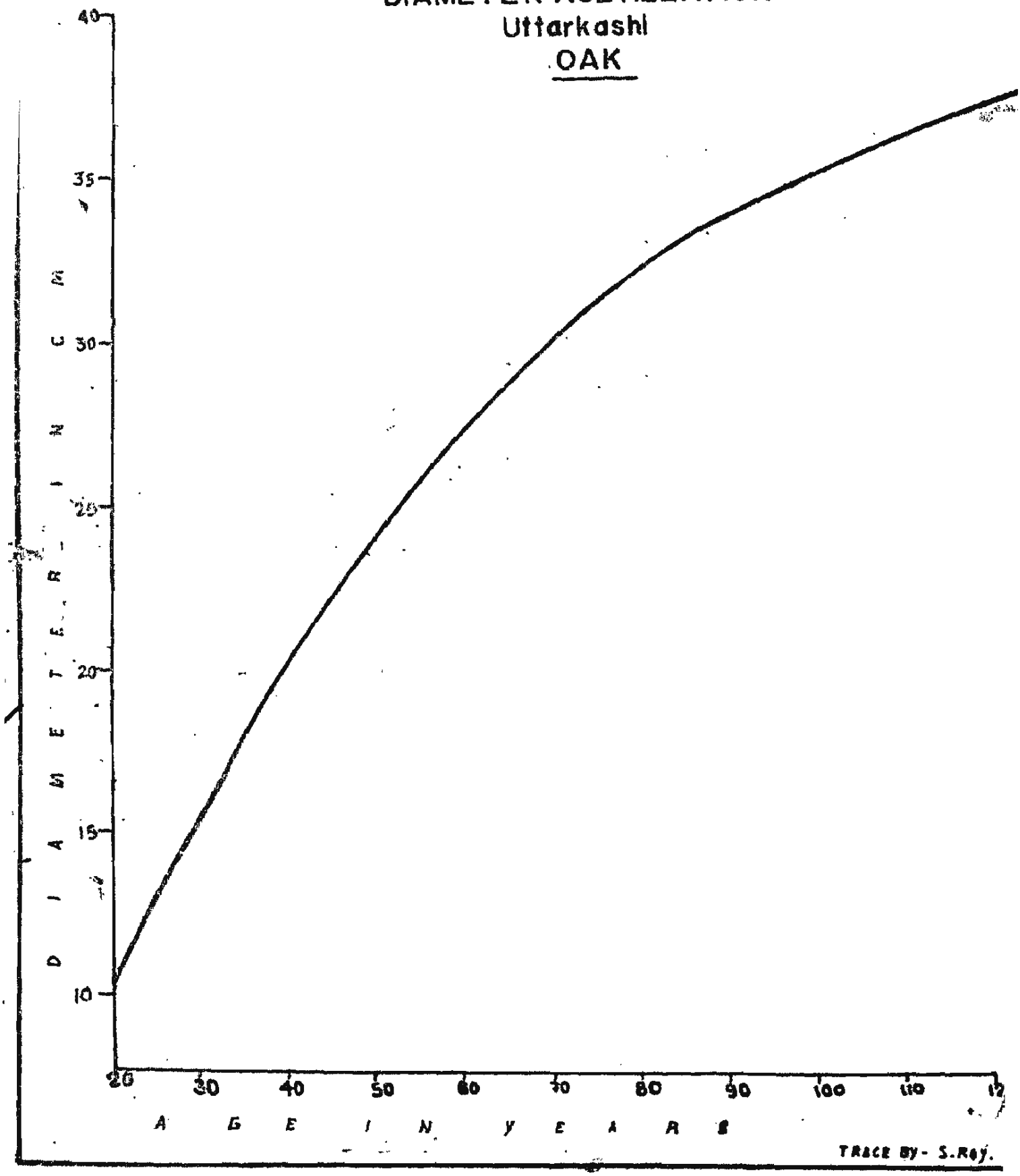
FIR - SPRUCE



TRACE BY- S. ROY

Fig. 5

DIAMETER-AGE RELATION
Uttarkashi
OAK



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